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WAR DEPARTMENT

TECHNICAL MANUAL

COAST ARTILLERY GUNNERS' INSTRUCTION, ANTIAIRCRAFT SEARCHLIGHT BATTERIES, FIRST AND SECOND CLASS GUNNERS

December 3, 1941

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WAR DEPARTMENT,
WASHINGTON 25, D. C., 16 July 1943.

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BY ORDER OF THE SECRETARY OF WAR:

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Chief of Staff.

OFFICIAL:

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Prepared under direction of the
Chief of Coast Artillery

CHAPTER 1

GENERAL

1. Purpose and scope.—*a. Purpose.*—This manual is designed primarily for use by organization commanders in the instruction of

enlisted men of antiaircraft searchlight units of the Coast Artillery Corps. It may be used by officers conducting examinations of enlisted men for qualification as gunners, as contemplated by FM 4–150. The questions and answers in the manual are intended merely as a guide and should be supplemented by the extensive use of other questions and answers and by practical demonstrations.

b. Scope.—The topics included in this manual are those prescribed in FM 4–150 for qualification of enlisted men as first and second class gunners in antiaircraft searchlight units.

2. Assignment of topics.—The following is the general assignment of topics. Each organization should omit those portions of the assigned chapters, sections, and paragraphs that do not pertain to the particular equipment in use by the organization.

Subject	First class gunners	Second class gunners
Drill of searchlight section	----------	Chapter 2.
Nomenclature of various parts of searchlight.	----------	Chapter 3, sections I and II.
Nomenclature of various parts of sound locator apparatus.	----------	Chapter 3, section III.
Cordage and mechanical maneuvers	----------	Chapter 9.
Nomenclature, action, and maintenance of small arm with which the organization is equipped, and its ammunition.	----------	Chapter 8.
Motor transportation	Chapter 6, pars. 45–49, incl.	Chapter 6, pars. 43 and 44.
Care and operation of power plant	Chapter 4, section I.	
Care and operation of searchlight	Chapter 4, sections II and III.	
Care and operation of sound locator apparatus.	Chapter 4, section IV.	
Use and care of telephones	Chapter 5.	
Elementary definitions for antiaircraft artillery.	Chapter 7.	
Indication, identification, and characteristic features of the several classes of aircraft.	Chapter 10.	

CHAPTER 2

DRILL OF SEARCHLIGHT SECTION

3. Organization.—Instruction in drill will be practical, the candidate performing the duties of such members of the searchlight section as the examining board may direct. (See drill table at end of manual.)

Q. Of what personnel does the searchlight section consist? *A.* The searchlight section consists of one chief of section (a sergeant); one searchlight commander (a corporal); and ten privates, as follows: No. 1, azimuth listener; No. 2, elevation listener; No. 3, acoustic corrector operator; No. 4, telephone operator; No. 5, azimuth controller; No. 6, elevation controller; No. 7, searchlight operator; No. 8, power plant operator and chauffeur, Truck No. 2; No. 9, chauffeur, Truck No. 1; No. 10, basic, assistant to No. 8.

Q. What are the names of the squads in the searchlight section? *A.*

(1) The sound locator squad.
(2) The searchlight squad.

Q. Of what personnel does the sound locator squad consist? *A.* See figure 1.

Q. Of what personnel does the searchlight squad consist?—*A.* See figure 1.

4. Prepare for action.—*Q.* Who gives the command PREPARE FOR ACTION? *A.* The chief of section gives the command PREPARE FOR ACTION after the trucks of the section have reached the vicinity of the searchlight position. The command is repeated by the searchlight commander.

Q. What is done after the command PREPARE FOR ACTION is given? *A.* The chief of section designates the positions at which the searchlight, control station, power plant, and sound locator are to be placed. Truck No. 1 is driven to the searchlight position by No. 9, after which Nos. 1, 2, 5, 7, and 9 unload, set up, and level the searchlight under supervision of the chief of section. No. 7, searchlight operator, remains at the searchlight, connecting yellow, red, and blue cables to

the junction box after they have been delivered by truck No. 2, and otherwise prepares the light for action. No. 7 also removes the extended hand controller from truck No. 1 and places it close to the searchlight.

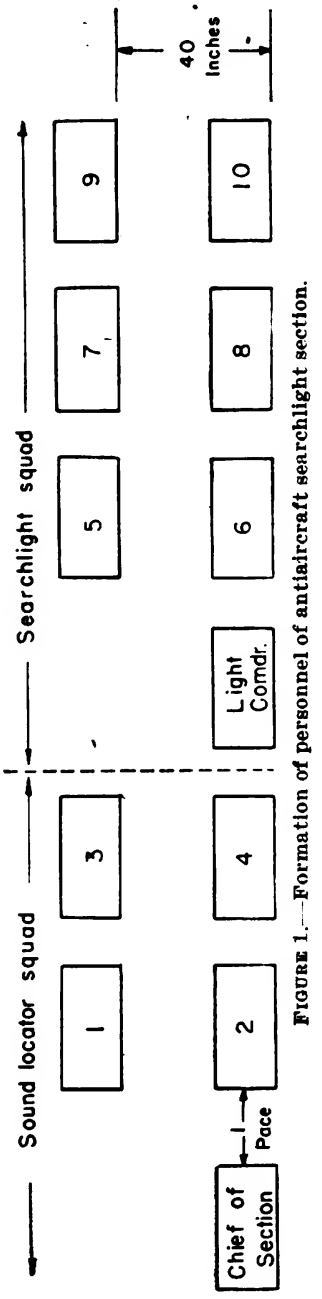


FIGURE 1.—Formation of personnel of antiaircraft searchlight section.

Q. After the searchlight is in position, what is done? *A.* Truck No. 1 proceeds to the control station position under supervision of the chief of section. Nos. 1, 2, and 5 set up the control station. No.

5 procures the automatic rifle from the truck, places it near the control station, and then levels the control station. When the red cable is delivered by truck No. 2, he connects it to the control station.

Q. Where does Truck No. 1 go next? *A.* Truck No. 1 then goes to the sound locator position where Nos. 1, 2, and 9 unload and set up the sound locator under the supervision of the chief of section. No. 1 connects the blue cable to the sound locator after truck No. 2 has delivered the cable to the sound locator position. Nos. 1 and 2 level the sound locator. No. 2 installs the pantograph and drives stakes to indicate the direction of advanced listening posts and the other four searchlights of the platoon. No. 9 then drives the truck to the parking area selected by the chief of section, checks his truck, and then performs duties as indicated by the chief of section.

Q. What does truck No. 2 do at the command PREPARE FOR ACTION? *A.* After finding out where the equipment is to be located, No. 8 drives truck No. 2 to the power plant position, where Nos. 3, 6, 8, and 10 unload the power plant. No. 8, the power plant operator, places the automatic weapon near the power plant. Nos. 3 and 6 carry the power cable reel to the rear of the truck and pay out the positive and negative yellow power cables as truck No. 2 moves toward the searchlight position. No. 10 holds the power cables in place as truck No. 2 moves off, and then connects the cables to the power plant. Thereafter No. 10 performs duties as indicated by the chief of section. When truck No. 2 arrives at the searchlight, the power cable reel is moved out of the way and the red and blue cable reels are moved to the rear of the truck. The truck then moves toward the control station, paying out the red cable. If the sound locator is located so that blue cable to it may also be payed out, this is done at the same time, otherwise, each cable is laid separately. When both are laid at the same time, No. 3 pays out the *blue* cable and the searchlight commander the *red* cable. No. 6 walks behind the truck, forcing both cables to one side so as to allow passage for vehicles without damage to the cables. If each cable is payed out separately, No. 3 pays out both red and blue cables; the searchlight commander assists either No. 3 or No. 6, as he thinks necessary. After the cables are laid, truck No. 2 is driven to the prescribed parking area by No. 8, who checks his truck and thereafter performs duties as indicated by the chief of section. Nos. 3 and 6 proceed to the sound locator and control station positions, respectively.

Q. What are the duties of No. 4, the telephone operator, at the command PREPARE FOR ACTION? *A.* After learning from the chief of section where the telephone line is located, he leaves truck No. 2

and proceeds on foot to connect his telephone to establish communication with platoon headquarters. When this is accomplished he reports to the chief of section.

Q. Do the personnel of truck No. 2 wait until the duties of the personnel of truck No. 1 are completed before starting their duties? *A.* No. The personnel of truck No. 2 perform their duties at the same time to avoid unnecessary delay.

5. Examine equipment.—*Q.* Who gives the command EXAMINE EQUIPMENT? *A.* The chief of section gives the command EXAMINE EQUIPMENT as soon as all equipment is placed properly and cables are connected.

Q. What is done at the sound locator at the command EXAMINE EQUIPMENT? *A.* The chief of section verifies the proper functioning of all equipment and personally supervises the orientation and synchronization of the unit. Nos. 1 and 2 test the elevating and traversing mechanisms, and verify that the sound locator is leveled. Nos. 1, 2, and 3 then orient the sound locator. No 3 inspects the acoustic corrector, is given the parallax correction by the chief of section and sets it on the parallax cam scale, and assists Nos. 1 and 2 with the orientation. No. 2 also tests the cut-out switch which reduces noise from the data transmitters. Nos. 1 and 2 then adjust their listening helmets for fit, and as a test connect each helmet properly to the aluminum elbows fixed to the flexible tubing from the horns. No. 4 tests communication to the platoon command post. Any failure of equipment to function properly is reported to the chief of section.

Q. What is done at the control station at the command EXAMINE EQUIPMENT? *A.* The searchlight commander inspects the proper functioning of the searchlight, power plant, and control station. He directs the orientation and synchronization of the searchlight and control station with the sound locator. Nos. 5, 6, and 7 assist in the orientation and synchronization. Nos. 5 and 6 inspect the azimuth and elevation control mechanisms, and also test the distant electric control (D. E. C.) in azimuth and elevation, respectively. No. 5 inspects the automatic rifle to include the proper supply of ammunition. No. 6 tests the buzzer by means of the buzzer signal switch.

Q. What is done at the searchlight when the command EXAMINE EQUIPMENT is given? *A.* No. 7 inspects all cable connections and the proper leveling of the searchlight. He then assures himself that the dynamotor is functioning, that the lamp is carboned, and that spare carbons are on hand. When the power is delivered from the power plant he tests the proper functioning of the lamp mechanism and feeding of the carbons. *Important:* No. 7 assures himself that

the arc is functioning properly, carbons are positioned properly, and that the arc operates at 78 volts with 150 amperes flowing through it *PROVIDED THE PLATOON COMMANDER AUTHORIZES THIS ACTION.* (Striking the arc may give away the searchlight position at night.) The searchlight commander, assisted by No. 7, orients and synchronizes the searchlight. Nos. 5 and 6, at the control station, assist in these operations.

Q. What is done at the power plant at the command EXAMINE EQUIPMENT? *A.* No. 8 examines the power plant. He inspects the oil, water, and gasoline supply to insure a sufficient supply, and assures himself that cables are connected properly. No. 8 then proceeds to start the engine and adjust the generator voltage. (See Operator's Manual, which is furnished with each power plant, for exact procedure. *No. 8 has an important position and must thoroughly familiarize himself with the operation of the power plant.*) When No. 7 is permitted to strike the arc, a more exact adjustment of the voltage and current may be made by No. 8, since No. 7 can tell No. 8 what voltage and current are delivered to the searchlight. No. 8 also examines the automatic rifle and assures himself that a sufficient supply of ammunition is on hand.

Q. What do Nos. 9 and 10 do at this time? *A.* No. 9, after driving truck No. 1 to the prescribed parking area, checks the water, gasoline, oil, and operation of his truck. After truck No. 2 is parked in the prescribed parking area, No. 10 inspects it for water, gasoline, oil, and correct operation. Nos. 9 and 10 check concealment of their respective trucks. No. 10 then assists No. 8 at the power plant.

6. Commands of rest, stand by, track, in action, out of action, change target, and march order.—*Q.* Who gives the command REST, and what is done? *A.* If no action is probable, or when ordered by the platoon commander, the chief of section commands REST. The command is repeated by the searchlight commander. During rest periods, the chief of section arranges men in reliefs for the necessary posts as shown in the drill table under column headed REST.

Q. What is done at the command STAND BY? *A.* This command is given by the chief of section when a target is detected, when an adjacent light goes into action, or when he receives the order STAND BY from the platoon commander. The order is repeated by the searchlight commander. At this command all men of the searchlight section are alerted and take their respective posts, performing the duties outlined in the drill table under column headed STAND BY.

Q. What is done at the command TRACK? *A.* This command is given by the chief of section when the sound locator crew report "On target." The command is repeated by the searchlight commander. Each man performs his duties so that the light may go into action at the proper command. See drill table under column headed TRACK for duties performed by each member of the section.

Q. Who gives the command IN ACTION and what is done? *A.* The chief of section gives this command. It is repeated by the searchlight commander who signals No. 7, using the buzzer. No. 7 then closes the arc switch. Exact duties for each man appear under the column headed IN ACTION in the drill table.

Q. Who gives the command OUT OF ACTION, and what is done at this command? *A.* The command is given by the chief of section. It is repeated by the searchlight commander who signals No. 7, using the buzzer, whereupon No. 7 opens the main arc switch and extinguishes the arc. Other duties are as listed in column headed OUT OF ACTION in the drill table.

Q. If a new target is assigned, what is the command to give? *A.* CHANGE TARGET. The chief of section causes the sound locator and searchlight to pick up the new target as outlined in column headed CHANGE TARGET in the drill table.

Q. Who gives the command MARCH ORDER? *A.* On order from the platoon command post, the chief of section gives this command. The duties performed are the opposite of those performed in PREPARE FOR ACTION. Exact duties are listed in the drill table under the column MARCH ORDER.

7. Drill table.—See insert at back of manual.

CHAPTER 3

NOMENCLATURE OF VARIOUS PARTS OF SEARCHLIGHT SECTION EQUIPMENT

SECTION I

SPERRY SEARCHLIGHT EQUIPMENT

8. Searchlights.—*Q.* In learning the names of the various parts, what should you bear in mind? *A.* In addition to learning the names of the various parts, you should also find out for what purpose each part is used, and how it works.

Q. What are the operating voltage and current for the arc of the Sperry searchlights? *A.* The arc operates at a voltage of 78 volts and a current of 150 amperes.

Q. What is the maximum range of a searchlight? *A.* This depends on atmospheric conditions. An average value of 10,000 yards is given as an approximate maximum range under good conditions.

Q. Modern searchlights have metal mirrors. What shape or type of mirror is it? *A.* These mirrors are parabolic mirrors. This means that if a source of light is emitted from the *focal point* of the mirror, the rays of light are reflected in *parallel rays of light.*

Q. What is the beam candlepower (an ordinary candle is rated as 1 candlepower) of the Sperry searchlight? *A.* It is rated at 800 million candlepower.

Q. What causes such a great amount of light in the beam? *A.* This is caused by the burning of gases in the positive carbon crater.

Q. In general, how long do the positive and negative carbons burn? *A.* All carbons burn for approximately 1½ hours.

Q. In how many ways may the carbons be fed? *A.* Three: automatically, semiautomatically, or by hand.

Q. How can you tell the positive carbon from the negative carbon? *A.* The positive carbon is longer and thicker than the negative carbon. When issued the positive carbon is 22 inches long and 0.633 inch in diameter; the negative carbon is 12 inches long and 0.434 inch in diameter.

Q. Which carbon burns out first? *A.* The positive carbon. For this reason the arc must be watched carefully so that the positive nose cap is not melted.

Q. Do all antiaircraft searchlights have an extended hand controller for pointing the light manually? *A.* Yes.

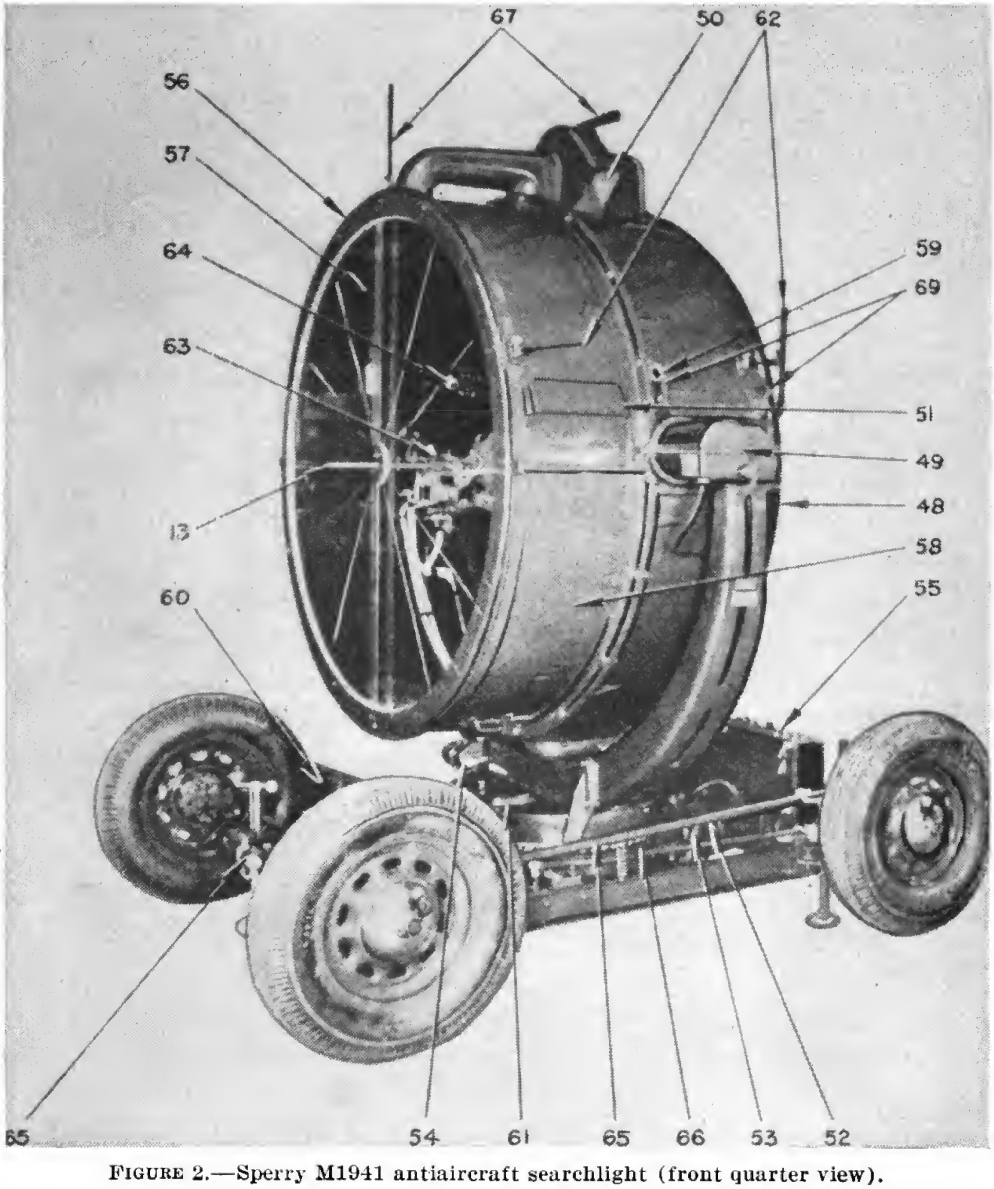


FIGURE 2.—Sperry M1941 antiaircraft searchlight (front quarter view).

Q. Point out the various parts of the searchlight with which your unit is equipped. While pointing out each part, describe its use. *A.* See figures 2, 3, 4, and 5.

NOTE.—All Sperry searchlights are similar except as noted under columns headed "Part" and "Purpose or use."

Part	Purpose or use
13. Positive carbon	When burning, light comes from incandescent gas which forms in the positive crater.
48. Rear drum	Made of aluminum alloy, it houses and supports the metal mirror and the arc lamp column on which is mounted the lamp unit.
49. Elevation data receiver housing. (Not part of 1934 and M–VI lights. M–VI light has a transmitter instead of a receiver at this location.)	It houses the elevation data receiver which is connected electrically by cable to the sound locator elevation data transmitter. The receiver causes the elevation zero readers (one at the searchlight and one at the control station) to indicate elevation data. (For the M–VI light only: The transmitter sends data to the comparator giving the position of the light.)
50. Ventilating motor and exhaust vent.	This motor causes fresh air to be drawn into the drum, and it exhausts burnt gases from the arc through the exhaust vent.
51. Ventilating fan intake vents.	Fresh air enters the drum at five intake vents.
52. Azimuth control motor	This motor causes the searchlight to rotate in azimuth and is controlled by the azimuth distant electric control handwheels at the control station. (For the M–VI light only: A control switch for this motor is mounted under main power receptacles.)
53. Azimuth motor clutch lever.	When clutch lever is in the out position, the shaft of the azimuth control motor is disconnected. When the clutch lever is in, the azimuth control motor shaft is connected to the searchlight ring gear and can turn the light in azimuth.
54. Azimuth scale lamp	To furnish illumination so azimuth scale may be set to correct azimuth when orienting.
55. Junction box	All cables are connected to the junction box, and wiring goes out of the junction box to connect the proper circuit.
56. Front drum	Made of sheet duralumin, it is bolted to the rear drum, and supports the front door.
57. Glass door	This glass protects the arc from wind and rain. The 12-segment construction makes it shockproof.
58. Sliding panel	There are two sliding panels, one on each side of the front drum, to permit access to the interior of the drum for maintenance and recarboning.
59. Arc view peep sight	To observe the condition and position of the arc.
60. Ballast resistor	Encased in a housing, this resistor is in the arc circuit to give the arc stability so it will not sputter. *Never adjust this resistor except under direction of an electrician sergeant or an officer.*
61. Handhold plate	Permits access into the base to inspect brushes and slip rings which form a part of various circuits, including the main arc circuit.
62. Elevation daylight sights	These are provided so that the error in pointing the searchlight in elevation may be determined. The sights are graduated in mils.
63. Lamp unit	Mechanism for supporting and feeding the carbons.
64. Recarboning lamp	To give illumination inside the drum when recarboning the lamp at night.
65. Steering tongue and lug	For steering the searchlight.
66. Transportation bar	To lock the searchlight drum in its traveling position.
67. Azimuth daylight sights	These are provided so that the error in pointing the searchlight at the target in azimuth may be determined.
69. Orienting sights	For use in orienting the searchlight with sound locator. (On earlier models than the M1941, the orienting sights are mounted on the *right side* of the drum.

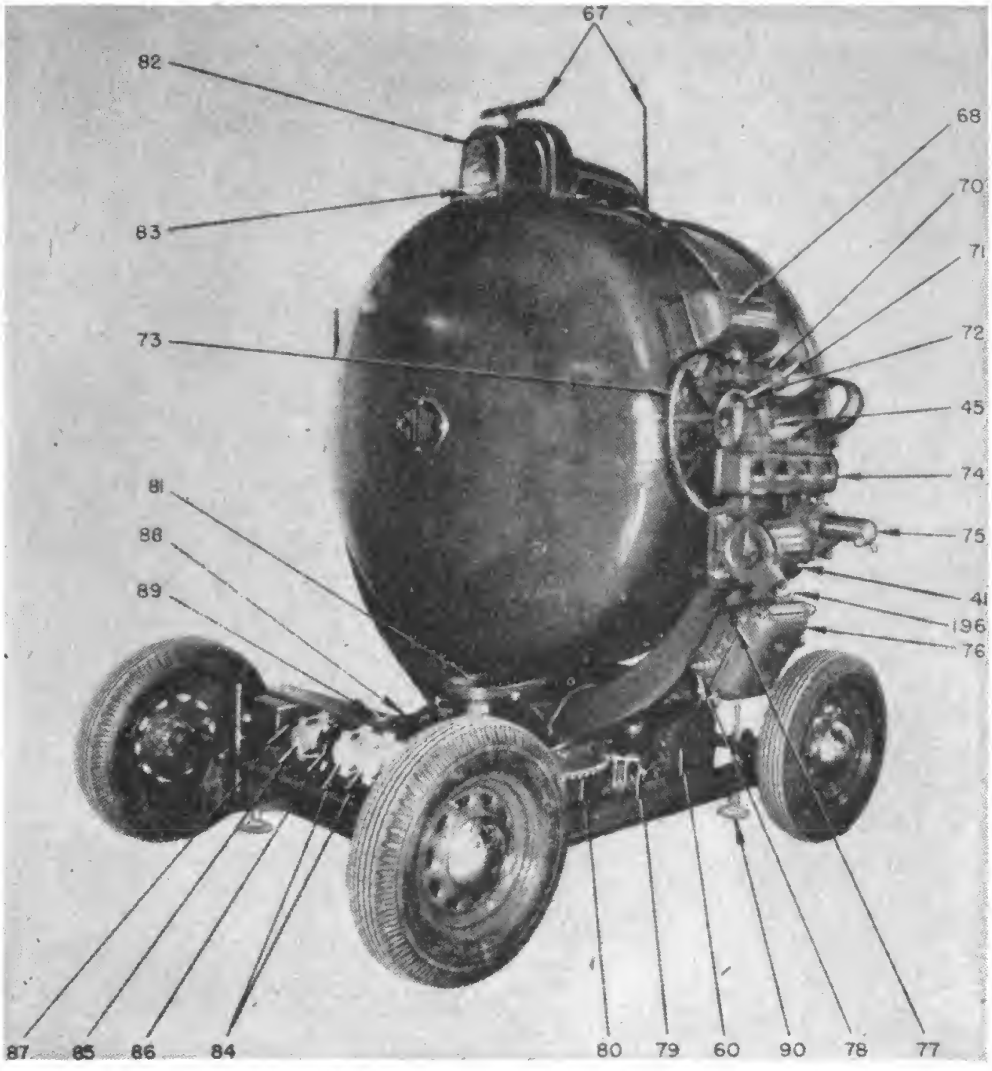


FIGURE 3.—Sperry M1941 antiaircraft searchlight (rear quarter view).

Part	Purpose or use
41. Elevation control motor	This motor causes the searchlight to elevate or depress and is controlled by the elevation distant electric control handwheels at the control station. (For the M–VI light only: A control switch for this motor is mounted on the right trunnion arm.)
45. Arc view peep sight	To observe the condition and position of the arc.
60. Ballast resistor	Encased in a housing, this resistor is in the arc circuit to give the arc stability so it will not sputter. *Never adjust this resistor except under direction of an electrician sergeant or an officer.*
67. Azimuth daylight sights	These are provided so that the error in pointing the searchlight in azimuth may be determined.
68. Lamp control mechanism box.	This box houses the mechanism which automatically feeds the carbons so that the arc operates at a voltage of 78 volts and a current of 150 amperes.
70. Recarboning lamp switch	Turns on the recarboning lamp. The scale and meter light switch must be on also, except on the M–VI light.

Part	Purpose or use
71. Elevation scale lamp	To illuminate the elevation scale when orienting.
72. Elevation scale	It is used for orienting and pointing the light in elevation.
73. Elevation gear sector	The elevation control motor and the elevation extended hand control are geared to this gear sector so that the light may be elevated or depressed.
74. Meter box	It contains an azimuth zero reader, an elevation zero reader, an ammeter to check the arc current at 150 amperes, and a voltmeter to check the arc voltage at 78 volts. (For the M1937 light only: The elevation zero reader is mounted near the left trunnion on its receiver, the azimuth zero reader on the base of the light near its receiver.) (For the M-VI and M1934 lights only: There are no zero readers on these lights.)
75. Hand controller socket	The extended hand controller fits into this socket.
76. Arc switch box	This box houses the arc switch.
77. Extension lamp receptacle.	A trouble lamp extension cord is connected to this receptacle.
78. Scale and meter light switch.	Lights lamps so that the meter box instruments can be seen, and also turns on the azimuth and elevation scale lamps.
79. Azimuth lock	Locks searchlight in azimuth traveling position.
80. Azimuth scale	For orienting the searchlight in azimuth.
81. Azimuth data receiver housing. (Not part of M1934 and M-VI lights. M-VI light has a transmitter instead of a receiver at this location.)	It houses the azimuth data receiver which is connected electrically by cable to the sound locator azimuth data transmitter. The receiver causes the azimuth zero readers (one at the searchlight and one at the control station) to indicate azimuth data. (For the M-VI light only: The transmitter sends data to the comparator giving the light position.)
82. Ventilating motor housing.	Houses ventilating motor and fan.
83. Transportation lock bar lug.	The transportation bar is locked to this lug so that the drum can be locked in its traveling position.
84. Power cable receptacles	Painted yellow. The yellow positive and negative power cables are connected here.
85. Control station cable receptacle.	Painted red. The red cable from the control station is connected here.
86. Sound locator cable receptacle. (Not part of the M-VI and M1934 lights since this cable goes to comparator directly on these models. The M-VI light has a white receptacle and a green receptacle at this location.)	Painted blue. The blue cable from the sound locator connects to this receptacle. (For the M-VI light only: The white cable for sending searchlight position data to the comparator connects to the white receptacle. The green cable for delivering 110 volts alternating current for the a-c data transmission system connects the green receptacle to the power unit.)
87. Signal buzzer. (Not part of the M-VI or M1934 lights.)	The buzzer switch-button at the control station is closed when the searchlight is to be put IN ACTION.
88. Dynamotor (behind wheel). (For the M-VI light it is located at the power plant. For the M1934 unit it is located at the control station.)	This is a motor generator. The motor operates at line voltage, driving the generator which generates 110-volt *alternating current* to operate the data transmission system.
89. Dynamotor pilot light	A red light indicates that there is a-c power for the data transmission system.
90. Leveling jacks	For leveling the searchlight. Two levels are provided on the base of the searchlight for this purpose.
196. Recarboning safety switch. (Found only on the M1941 light.)	*Switch must be thrown to recarboning position before entering drum, otherwise a person may be killed.*

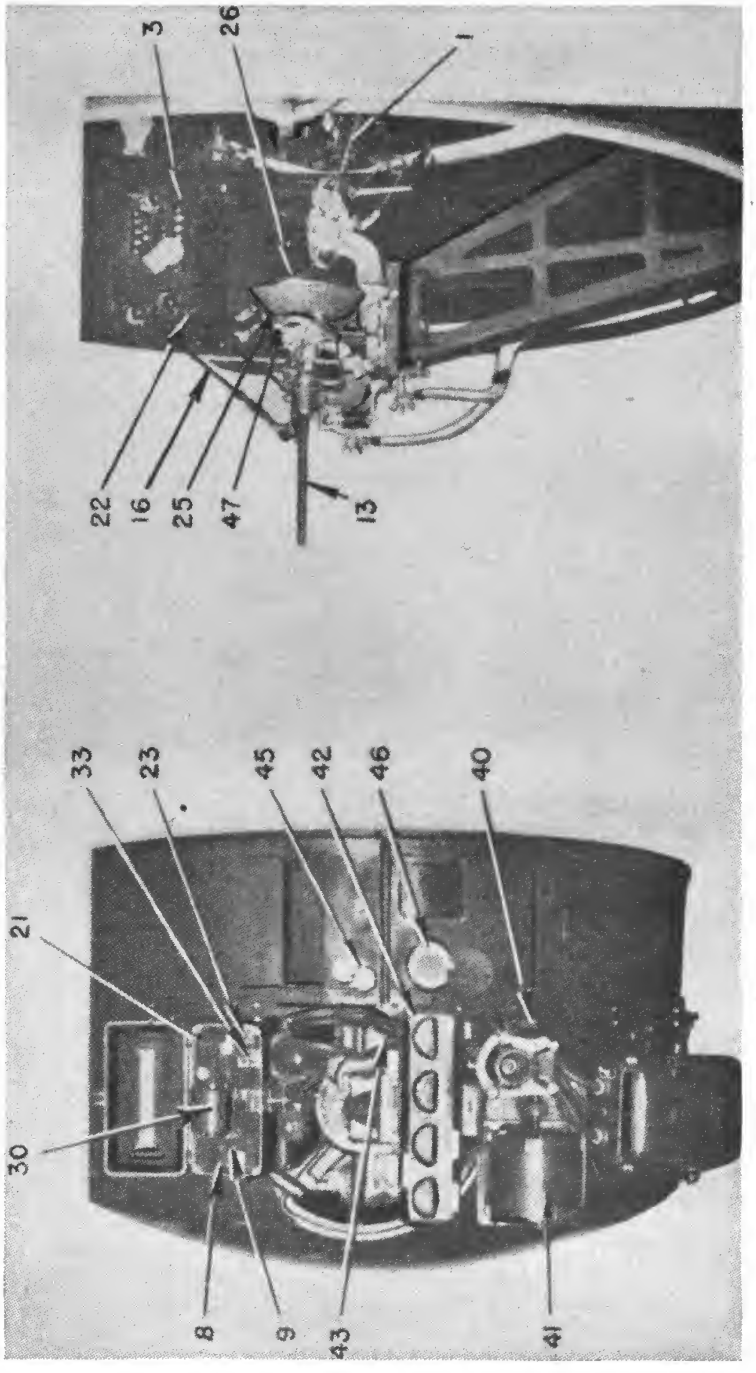
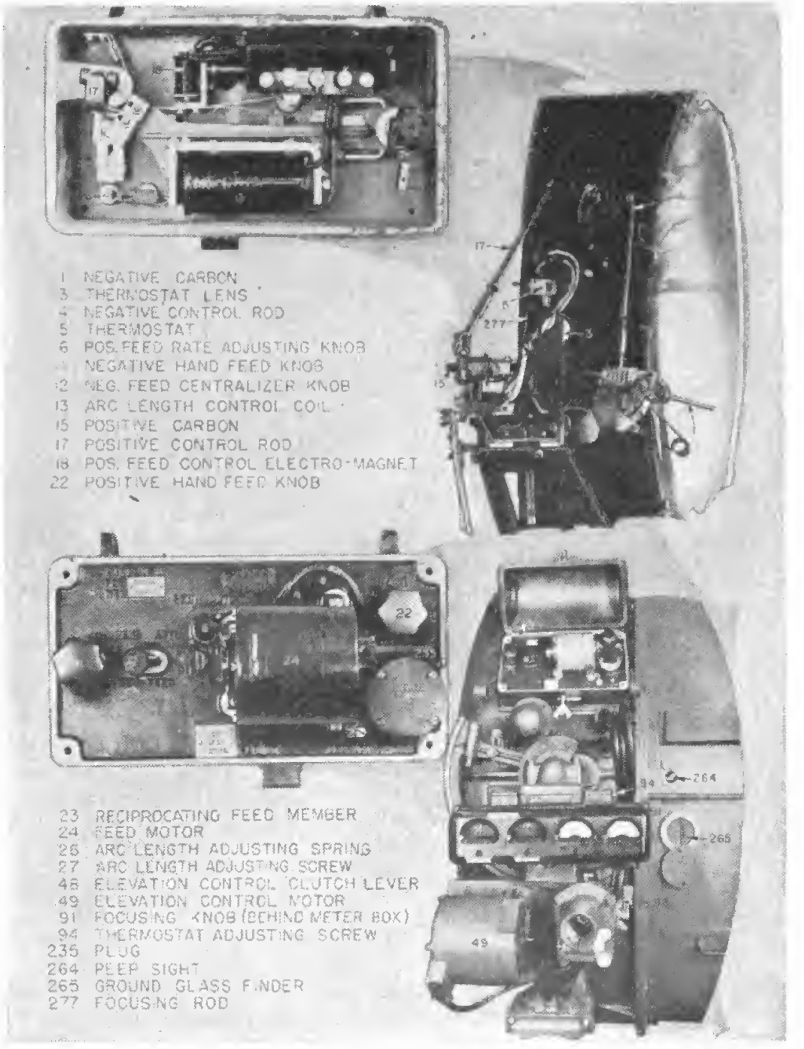


FIGURE 4.—Lamp and lamp control mechanism, Sperry M1941 searchlight.

Part	Purpose or use
1. Negative carbon	This carbon, plus the positive carbon, allows the arc to function by having *direct current* pass through it.
3. Negative control rod	This rod rotates so as to feed the negative carbon forward or backward.
8. Negative hand feed knob	Turning this knob by hand turns the negative control rod and feeds the negative carbon. Keep voltmeter voltage at 78 volts by turning this knob when using hand feed.
9. Negative feed centralizer lever.	When this lever is moved to its auto position, the negative carbon feeds automatically. When moved to hand position, the negative carbon must be fed by hand. (See part 8 above.)
13. Positive carbon	When the arc is operating, the positive carbon burns, causing incandescent gas to form a positive crater. From this crater comes the brilliant light for the beam.
16. Positive control rod	This rod rotates counterclockwise so that the positive carbon may be fed forward and rotated to cause the positive crater to burn evenly.
21. Positive hand feed handwheel.	Rotating this handwheel counterclockwise rotates the positive control rod so as to feed and rotate the positive carbon.
23. Positive feed rate adjustment screw.	Adjust this screw so that the normal rate of feed (one click) is *slightly less* than the rate of burning of the positive carbon. This normal rate of feed allows the positive carbon to burn back slowly so that the thermostat may act to keep the positive crater at the focal point of the metal mirror.
25. Thermostat	When the positive carbon burns back, the positive crater moves away from the focal point of the mirror. This causes rays of light to be focused on a bimetallic strip which is warped by the heat from the light rays. When the bimetallic strip warps it closes a circuit which automatically causes the positive carbon to feed forward to the focal point of the mirror.
26. Thermostat lens	This lens focuses rays of light so as to cause the thermostat to operate.
30. Feed motor	This motor activates the feed mechanism so that the positive and negative carbons may be fed automatically.
33. Arc length adjustment screw.	In automatic operation, this screw is adjusted so that the arc voltage is 78 volts as read on the voltmeter.
40. Elevation control clutch lever.	With this clutch in the D. E. C. position, the searchlight is elevated or depressed by distant electric control. With the clutch in the hand position, the extended hand controller is used to elevate or depress the searchlight.
41. Elevation control motor	See figure 3.
42. Focusing knob (behind meter box).	Turning this knob moves the lamp unit back and forth on the arc lamp column. By this means the positive crater is moved to the focal point of the mirror.
43. Thermostat adjusting screw.	This screw adjusts the distance between the contacts of the thermostat bimetallic switch.
45. Peep sight	To observe the condition and position of the arc.
46. Ground glass finder	This is used to check accurately the position of the positive crater. The end of the positive carbon should terminate at the black or focal line. *Never allow the positive carbon to burn back beyond the red danger line.*
47. Focusing rod	This rod rotates when the focusing knob is turned, and moves the lamp unit so that the positive crater is at the focal point of the mirror.



NOTE.—The nomenclature of the M–VI, M1937, M1939, and M1940 Sperry lights is the same as that of the M1934 light.

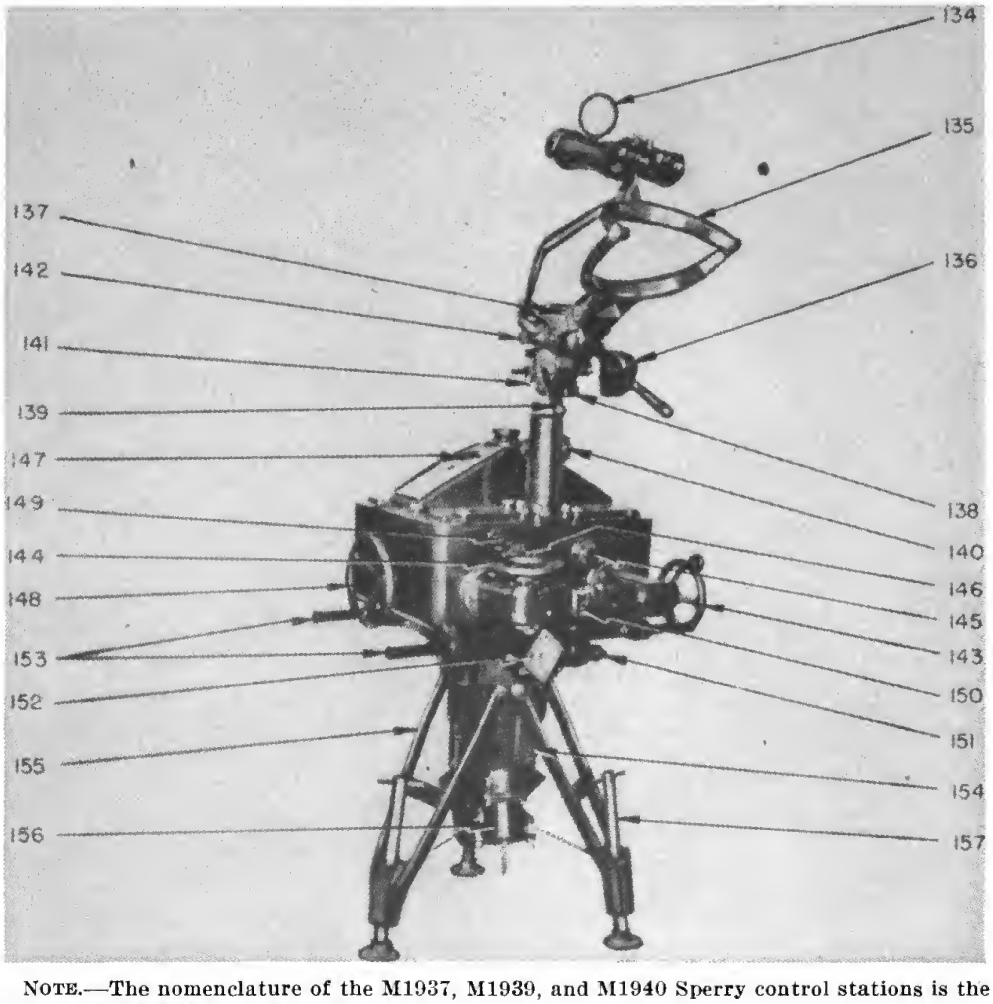
FIGURE 5.—Lamp and lamp control mechanism, Sperry M1934 searchlight.

Part	Purpose or use
1. Negative carbon	This carbon, plus the positive carbon, allows the arc to function by having *direct current* pass through it.
3. Thermostat lens	This lens focuses rays of light on the thermostat bimetallic strip.
4. Negative control rod	This rod rotates so as to feed the negative carbon forward or backward.
5. Thermostat	When the positive carbon burns back, the positive crater moves away from the focal point of the mirror. This causes rays of light to be focused on a bimetallic strip which is warped by the heat from the light rays. When the bimetallic strip warps, it closes a circuit which automatically causes the positive carbon to feed forward to the focal point of the mirror.
6. Positive feed rate adjusting knob	Adjust this knob so that the normal rate of feed (one click) is *slightly less* than the rate of burning of the positive carbon. This normal rate of feed allows the positive carbon to burn back slowly so that the thermostat may act to keep the positive crater at the focal point of the metal mirror.
11. Negative hand feed knob	Turning this knob by hand turns the negative control rod and feeds the negative carbon. Keep voltmeter voltage at 78 volts by turning this knob when using hand feed.
12. Negative feed centralizer knob	When this knob is moved to its auto position, the negative carbon feeds automatically. When moved to hand position, the negative carbon must be fed by hand.
13. Arc length control coil	This coil acts as a magnet and positions an armature which causes the negative carbon to feed so as to keep the arc length constant.
15. Positive carbon	When the arc is operating, the positive carbon burns, causing incandescent gas to form a positive crater. From this crater comes the brilliant light for the beam.
17. Positive control rod	This rod rotates counterclockwise so that the positive carbon may be fed forward and rotated to cause the positive crater to burn evenly.
18. Positive feed control electromagnet.	This magnet is energized when the thermostat operates. It pulls up a guard so that the positive carbon may be fed forward faster.
22. Positive hand feed knob	Rotating this knob counterclockwise rotates the positive control rod so as to feed and rotate the positive carbon.
23. Reciprocating feed member.	The part is moved back and forth by the feed motor and causes the positive and negative carbons to be fed.
24. Feed motor	This motor is the source of power for operating the feed mechanism.
26. Arc length adjusting spring.	This holds the armature in its correct position against the pull of the arc length control coil.
27. Arc length adjusting screw.	It adjusts the arc length adjusting spring so as to keep the arc voltage at 78 volts as read on voltmeter.
48. Elevation control clutch lever.	With this clutch in the D. E. C. position, the searchlight is elevated or depressed by distant electric control. With the clutch in the hand position, the extended hand controller is used to elevate or depress the searchlight.
49. Elevation control motor	Causes light to be elevated or depressed. It is controlled by the elevation operator at the control station.
91. Focusing knob (behind meter box).	Turning this knob moves the lamp unit back and forth on the arc lamp column. By this means the positive crater is moved to the focal point of the mirror.
94. Thermostat adjusting screw.	This screw adjusts the distance between the contacts of the thermostat bimetallic switch.
235. Plug	Removal of this plug provides access to the feed motor shaft.

9. Control stations.—*Q.* Why is a control station necessary? *A.* To obtain the best "contrast" the operator must be at least 50 feet away from the searchlight beam. At this distance an electrical remote control system must be used to point the searchlight in azimuth and elevation. The control station is a part of this remote control system, and from this station the searchlight may be pointed in azimuth and elevation.

Q. What is meant by contrast? *A.* Contrast means the difference between the amount of light reflected from the target and the amount of light reflected from the illuminated sky background. The better the contrast the better the target can be seen in the beam.

Q. In addition to being able to control the searchlight from a remote point, what other function must the control station perform? *A.* It must give an indication of sound locator data so that the search-



NOTE.—The nomenclature of the M1937, M1939, and M1940 Sperry control stations is the same as the M1941 control station.

FIGURE 6.—Sperry M1941 control station (binocular mount in position).

light may be pointed correctly. Also, the M1934 and later control stations have a means for searching 5° around sound locator data.

Q. How is searching accomplished on the Sperry control stations?

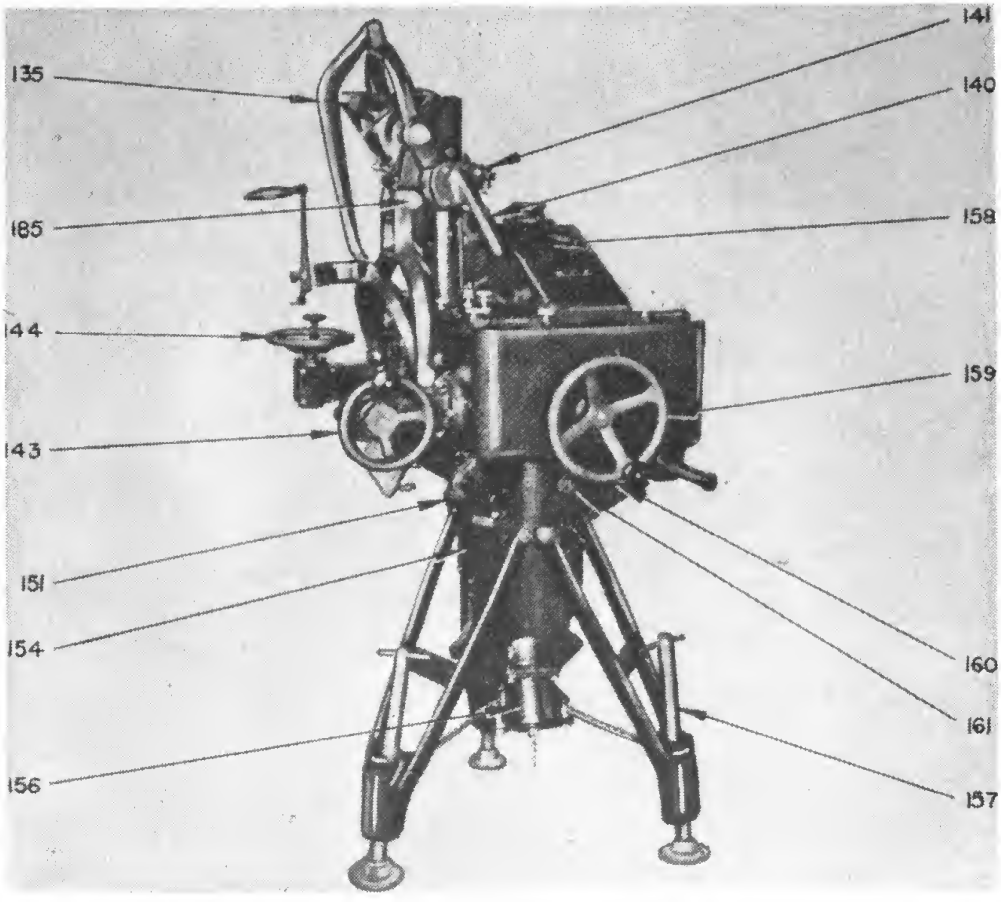
A. (1) For the M1939, M1940, and M1941 control stations only: Each zero reader has three graduations on its face: a center index and a graduation on either side of the index. Using the zero reader handwheel to move the pointer *slowly* between the outer graduations will cause the searchlight to search 5° around sound locator data.

Part	Purpose or use
134. Open sight	For getting approximately on a target and for orienting the control station
135. Binocular mount	Supports binoculars. This mount is geared to the elevation zero reader handwheel so that binoculars may be pointed in elevation according to sound locator data. It moves in azimuth as the control unit moves.
136. Binocular mount counterweights.	To balance the binoculars.
137. Binocular elevation zero marker.	To establish zero elevation when orienting the control station.
138. Binocular azimuth zero marker.	To establish the correct azimuth when orienting the control station.
139. Binocular mount adjustment handles.	By grasping these handles the binocular mount can be moved in azimuth and elevation. They are used especially to put the binocular line of sight on the searchlight beam in case the beam is not seen in the binoculars.
140. Binocular height adjusting knob.	This knob allows adjustment of the binocular mount for individual height.
141. Binocular mount azimuth adjustment.	Tightening up on this adjusting nut tightens a spring friction disk so binocular mount does not move too easily in azimuth.
142. Binocular mount clutch adjustment.	This adjusting screw must be adjusted so that binocular mount does not move too easily in elevation.
143. Observer's elevation handwheel.	The observer uses this handwheel to track in elevation after the target is flicked.
144. Observer's azimuth handwheel.	The observer uses this handwheel to track in azimuth after the target is flicked.
145. Elevation drive slip clutch.	This clutch protects the elevation drive mechanism.
146. Azimuth drive slip clutch.	This clutch protects the azimuth drive mechanism.
147. Azimuth zero reader	This is a voltmeter whose pointer moves away from its center (zero) position as new sound locator azimuth data is received.
148. Azimuth zero reader handwheel.	This handwheel rotates the control station and operates the azimuth D. E. C., which traverses the searchlight. This causes the pointer of the azimuth zero reader to move to its zero position when the searchlight is pointed according to sound locator azimuth data.
149. Signal buzzer push button.	This is used to signal the searchlight to go IN ACTION or OUT OF ACTION.
150. Zero reader light switch.	The switch when turned on lights the zero reader dials.
151. D-c switch	The switch must be turned on before the D. E. C. can be used.
152. Alinement lug	This lug fits in a notch machined in the control unit. The lug and notch must be lined up when putting control unit on tripod.
153. Carrying handles	Self-explanatory.
154. Handhole cover plate	Access may be had to the slip rings which electrically connect red cable to interior of control station.
155. Tripod	Supports control unit.
156. Fifteen-point receptacle.	Red cable plug from searchlight fits into this receptacle.
157. Leveling jack	Adjustment of these jacks permits leveling of the control station by means of spirit levels.

(2) For the M1937 control station only: Pushing in the search control knob (located to the right of the azimuth zero reader) causes an electric motor to drive an oscillating mechanism, which causes an automatic oscillation in elevation of 5° around sound locator data. Rotating the search control knob slowly offsets the azimuth zero reader pointer which, when brought back to its center position, causes a 5° search in azimuth around sound locator data.

(3) For the M1934 control station only: An automatic spiral searching device, which causes a search in both azimuth and elevation of 5° around sound locator data, is controlled by a handwheel placed directly under the binocular mount. When the handwheel is rotated *slowly* the searchlight searches 5° around sound locator data.

Q. Name and give the functions of the various parts of the control station with which your organization is equipped. *A.* See figures 6, 7, 8, and 9.



NOTE.—The nomenclature of the M1937, M1939, and M1940 control stations is the same as the M1941 control station.

FIGURE 7.—Sperry M1941 control station (binocular mount folded down).

Part	Purpose or use
135. Binocular mount	See figure 6.
140. Binocular height adjusting knob.	See figure 6.
141. Binocular mount azimuth slip clutch.	See figure 6.
143. Observer's elevation handwheel.	See figure 6.
144. Observer's azimuth handwheel.	See figure 6.
151. D-c switch	See figure 6.
154. Handhole cover plate	See figure 6.
156. Fifteen-point cable receptacle.	See figure 6.
157. Leveling jacks	See figure 6.
158. Elevation zero-reader	This is a voltmeter whose pointer moves away from its center (zero) position as new sound locator elevation data is received.
159. Elevation zero-reader handwheel.	This handwheel elevates the binocular mount and operates the elevation D. E. C., which elevates the searchlight. This causes the pointer of the elevation zero reader to move to its zero position when the searchlight is pointed according to sound locator elevation data.
160. Spirit levels	These spirit levels are used to level the control station.
161. Clamp knob	Two knobs, on opposite sides of the control unit, lock the control unit to the tripod.
185. Binocular mount locking pin.	This locks the binocular mount in its operating position so mount will move in elevation.

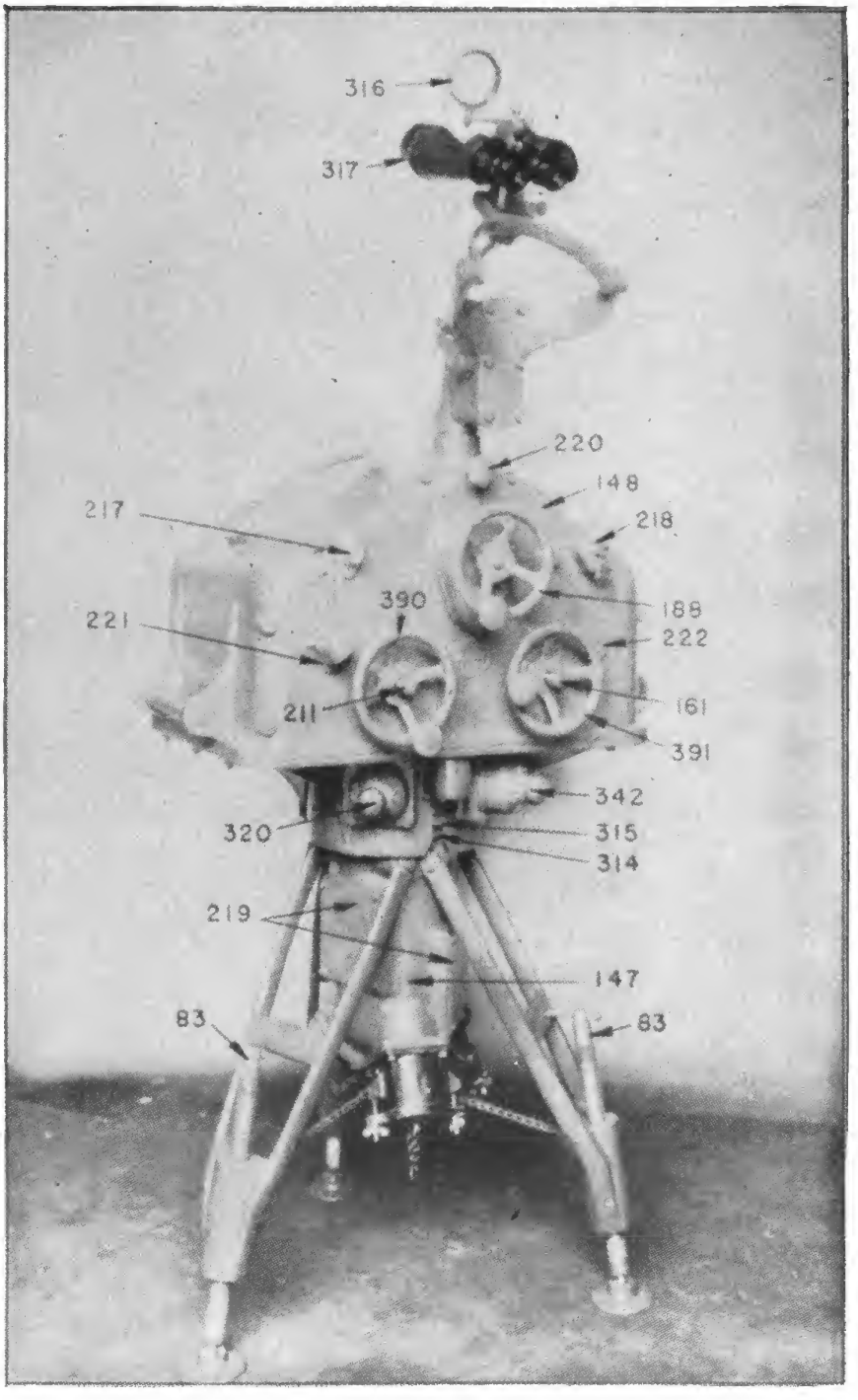


FIGURE 8.—Sperry M1934 control station.

Part	Purpose or use
83. Leveling jacks	Adjustment of these jacks permits leveling of the control station by means of spirit levels.
147. Tripod	Supports control unit.
148. Control unit	This unit houses the D. E. C. and comparator mechanism.
161. Elevation handwheel clutch knob.	With clutch in, the control station may be oriented and synchronized.
188. Searching handwheel	Rotation of this handwheel allows a search of 5° around sound locator data.
211. Azimuth handwheel clutch knob.	This knob is pushed in when orienting and synchronizing.
217. Sound locator azimuth dial synchronizing knob.	This knob is used to synchronize the azimuth receiver with the sound locator azimuth transmitter.
218. Sound locator elevation dial synchronizing knob.	This knob is used to synchronize the elevation receiver with the sound locator elevation transmitter.
219. Handhole cover plates	Removal of these three plates provides access to the slip rings and brushes.
220. Binocular height adjusting knob.	To adjust the binocular to any desired height.
221. Azimuth drive friction clutch adjustment screw.	Adjust this screw until a position is obtained at which the azimuth handwheel will slip if jerked.
222. Elevation drive friction clutch.	Adjust this screw until a position is obtained at which the elevation handwheel will slip if jerked.
314. Alinement slot	This slot must engage a lug on the tripod when setting up the control station.
315. Alinement lug	See remark above.
316. Open sight	For approximately orienting the control station.
317. Binocular	For searching the searchlight beam.
320. A-c switch	This switch supplies a-c power for the data transmission system.
342. D-c switch	This switch supplies d-c power for the distant electric control.
390. Observer's azimuth handwheel.	The observer can control the searchlight in azimuth by means of this handwheel. To the shaft of this handwheel on the opposite side of the control unit is the azimuth follow-the-pointer handwheel.
391. Observer's elevation handwheel.	The observer can control the searchlight in elevation by means of this handwheel. To the shaft of this handwheel, on the opposite side of the control unit, is attached the elevation follow-the-pointer handwheel.

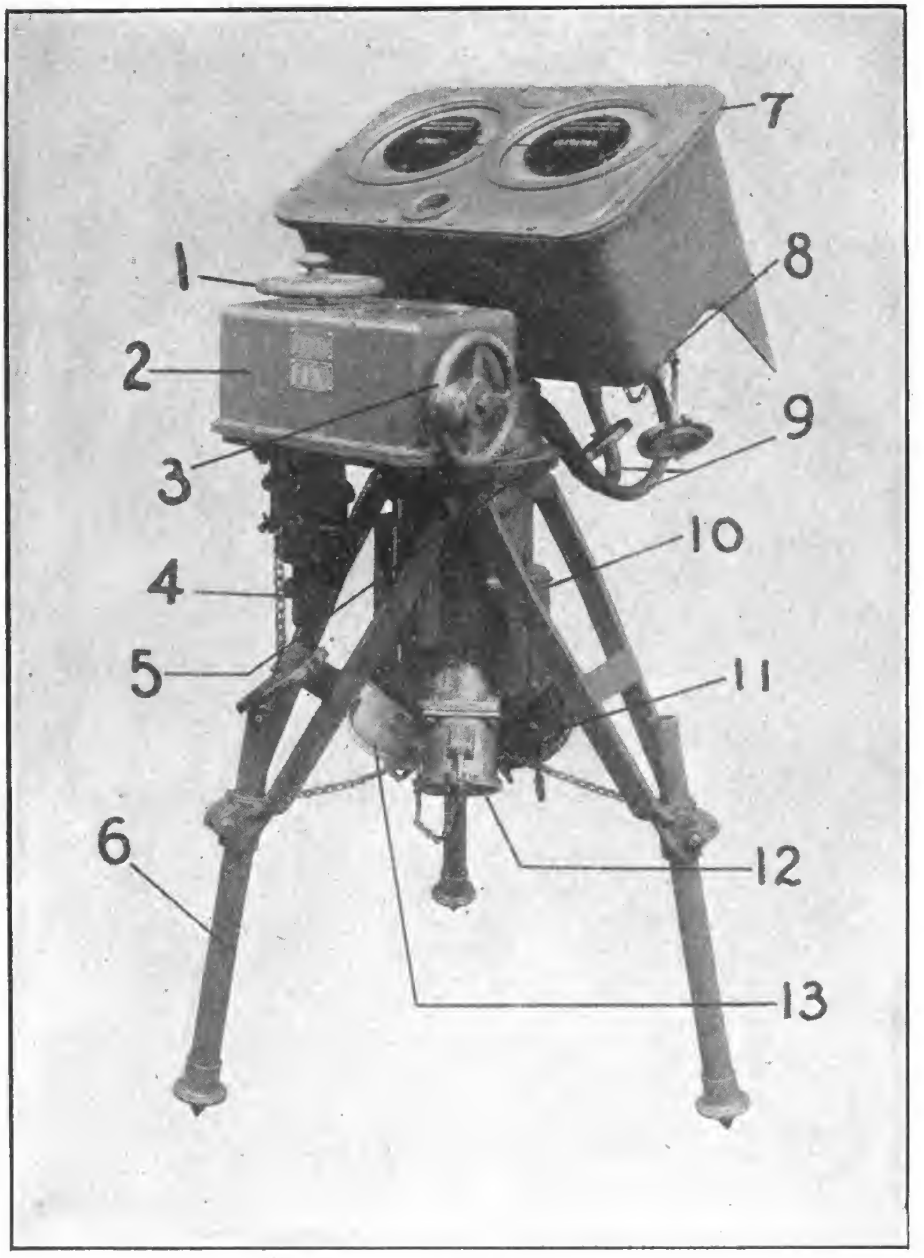


FIGURE 9.—Sperry M–VI control station.

Part	Purpose or use
1. Azimuth handwheel	This handwheel controls the searchlight in azimuth.
2. Searchlight controller	This houses the D. E. C. mechanism which causes the searchlight to be controlled remotely in azimuth and elevation from the control station.
3. Elevation handwheel	This handwheel controls the searchlight in elevation.
4. Cable from tripod to controller.	The wire conductors for the electric circuits of the D. E. C. are contained in this cable.
5. Azimuth training gear	Movement of the azimuth handwheel causes the comparator and controller to rotate in azimuth about the tripod by means of this gear.
6. Tripod	The tripod supports the controller and comparator.
7. A-c comparator	This houses four a-c synchronous receivers. Two are connected through the blue cable to the sound locator, one for azimuth, the other for elevation. The other two are connected by the white cable to the searchlight, one for azimuth, the other for elevation. The azimuth operator causes the two azimuth pointers to be matched, while the elevation operator matches the two elevation pointers.
8. Synchronizing knob	For synchronizing the receivers with their respective transmitters.
9. Cables from tripod to comparator.	Connects the four receivers to the white and blue cables.
10. Slip ring cover	Removing this cover provides access to the slip rings and brushes.
11. Receptacle for controller cable.	Painted red. This cable connects the controller to the searchlight training motors.
12. Receptacle for sound locator cable.	Painted blue. This cable connects the comparator sound locator data receivers to their respective transmitters at the sound locator.
13. Receptacle for searchlight cable.	Painted white. This cable connects the comparator searchlight receivers to their respective transmitters at the searchlight.

10. Power plants.—*Q.* What difference is there between the 1941 Sperry power plant and previous Sperry power plants? *A.* There is very little difference between the Sperry 1941 power plant and the previous models. The rated speed of the engine varies, but in general, all models back to and including the portable M1934 power plant are very similar.

Q. What is the rated engine horsepower of the 1941 Sperry power plant? *A.* It is rated at 42 hp at 1,100 rpm.

Q. What is the generator rating of the M1941 Sperry power plant? *A.* The generator is rated as follows:

Volts	*Amperes*	*Rpm*	*Kilowatts*
100	162	1,100	16.2

Q. Is the power plant engine similar to an ordinary automobile engine? *A.* Yes. It has a self-starter, battery, battery charging generator, water-cooling system, ignition, choke, and other features of an ordinary automobile engine.

Q. Point out the various parts, by name, of the power plant with which your organization is equipped. *A.* Refer to figures 10 and 11 for the M1941 Sperry power plant.

NOTE.—For the mobile M–VI, mobile M1934, portable M1934, M1937, M1939, and M1940 power units, refer to the Operator's Manual furnished with these units, using examination questions and nomenclature corresponding to those used in this manual.

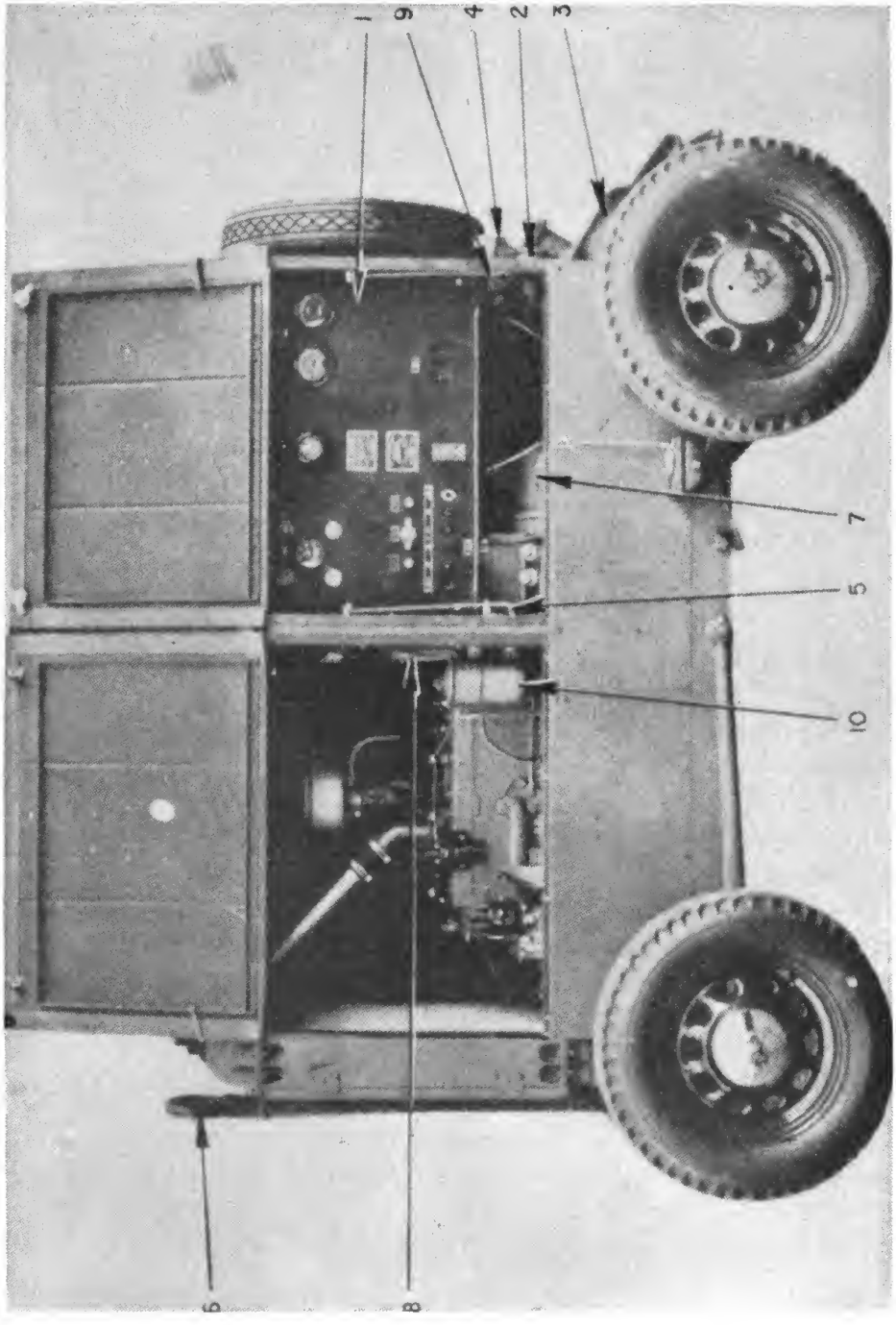


FIGURE 10.—Sperry M1941 power plant (left side).

Part	Purpose or use
1. Control panel	Contains all the necessary indicating instruments and equipment for controlling and operating the unit.
2. Power receptacles	Provides a convenient means of attaching and removing the two power cables that transmit the electrical power from the power plant to the searchlight. One receptacle is for the positive cable, the other receptacle for the negative cable.
3. Fuel tank	Gasoline supply for the engine. Capacity is 27½ gallons.
4. Tail lamp	Same purpose as tail lamp on automobile.
5. Control panel door bracket	Holds the control panel door in a horizontal position.
6. Tow bar	Used for towing and steering.
7. Power generator	A d-c compound wound generator which furnishes electrical power to operate the searchlight section.
8. Fan	Used for cooling the power plant. It is driven by a direct current ¾ hp motor.
9. Tail lamp switch	Turns tail lamp on or off.
10. Oil filter	Filters the oil in the engine.

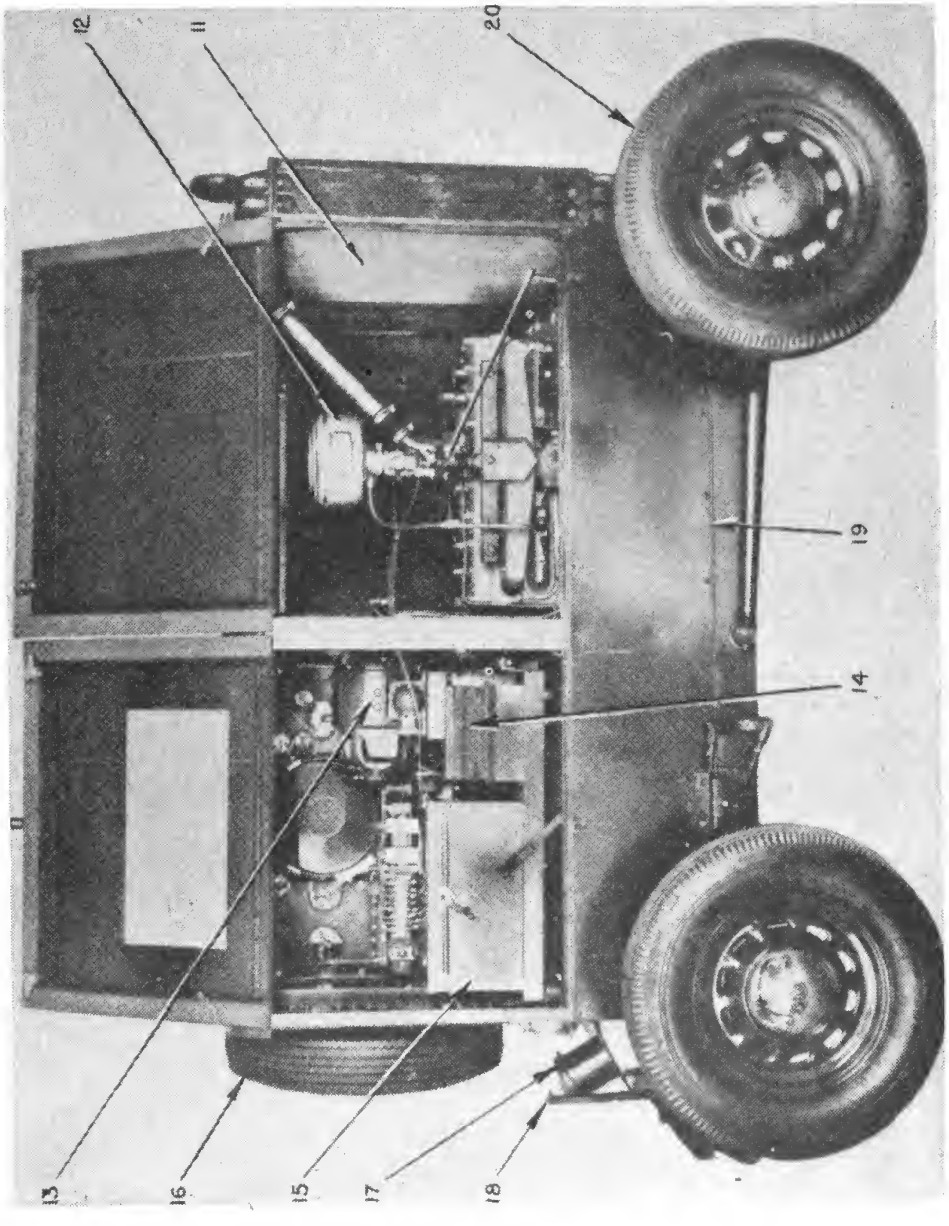


FIGURE 11.—Sperry M1941 power plant (right side).

Part	Purpose or use
11. Radiator	Cools the liquid in the engine cooling system.
12. Air filter	Filters the air going into the carburetor.
13. Fan motor	A ¾ hp, d-c motor, having two speeds: winter, 500 rpm; summer, 675 rpm.
14. Battery	Furnishes 6 volts for the engine ignition system and 6-volt lights on the control panel and tail light.
15. Tool box	Storage place for tools.
16. Spare wheel and tire	Self-explanatory.
17. Fuel tank filler pipe	Self-explanatory.
18. Brake lever	Self-explanatory.
19. Safety chain brake cable	Operates, in case the safety chain breaks, to apply the brakes on the power plant.
20. Exhaust	Self-explanatory.

SECTION II

GENERAL ELECTRIC SEARCHLIGHT EQUIPMENT

11. Searchlights.—*Q.* In learning the names of the various parts, what should you keep in mind? *A.* You should strive to learn not only the names of the parts, but should learn the purpose or use of each part.

Q. What is the operating voltage and current of the arc? *A.* It operates at 78 volts with a current of 150 amperes flowing through the arc.

Q. What is the maximum range of the searchlight? *A.* This depends on atmospheric conditions. An average value of 10,000 yards is given as an approximate maximum range under good conditions.

Q. What shape or type is the mirror of the searchlight? *A.* It is a metal parabolic mirror. This means that if a source of light is emitted from the *focal point* of the mirror, the rays of light are reflected in *parallel rays of light.*

Q. What is the beam candlepower? (An ordinary candle is rated at 1 candlepower.) *A.* It is rated at 800 million candlepower.

Q. What causes such a great amount of light in the beam? *A.* This is caused by the burning of gases in the positive carbon crater.

Q. In how many ways may the carbons be fed? *A.* Three: automatically, semiautomatically, or by hand.

Q. How can you tell the positive carbon from the negative carbon? *A.* The positive carbon is longer and thicker than the negative carbon. When issued the positive carbon is 22 inches long and 0.633 inch in diameter; the negative carbon is 12 inches long and 0.434 inch in diameter.

Q. Which carbon burns out first? *A.* The positive carbon. For this reason the arc must be watched carefully so that the positive nose cap is not melted.

Q. What piece of equipment is provided for hand control of the light in azimuth and elevation? *A.* An extended hand controller is provided for this purpose.

Q. Point out the various parts of the M1940 General Electric searchlight. *A.* See figures 12, 13, 14, and 15.

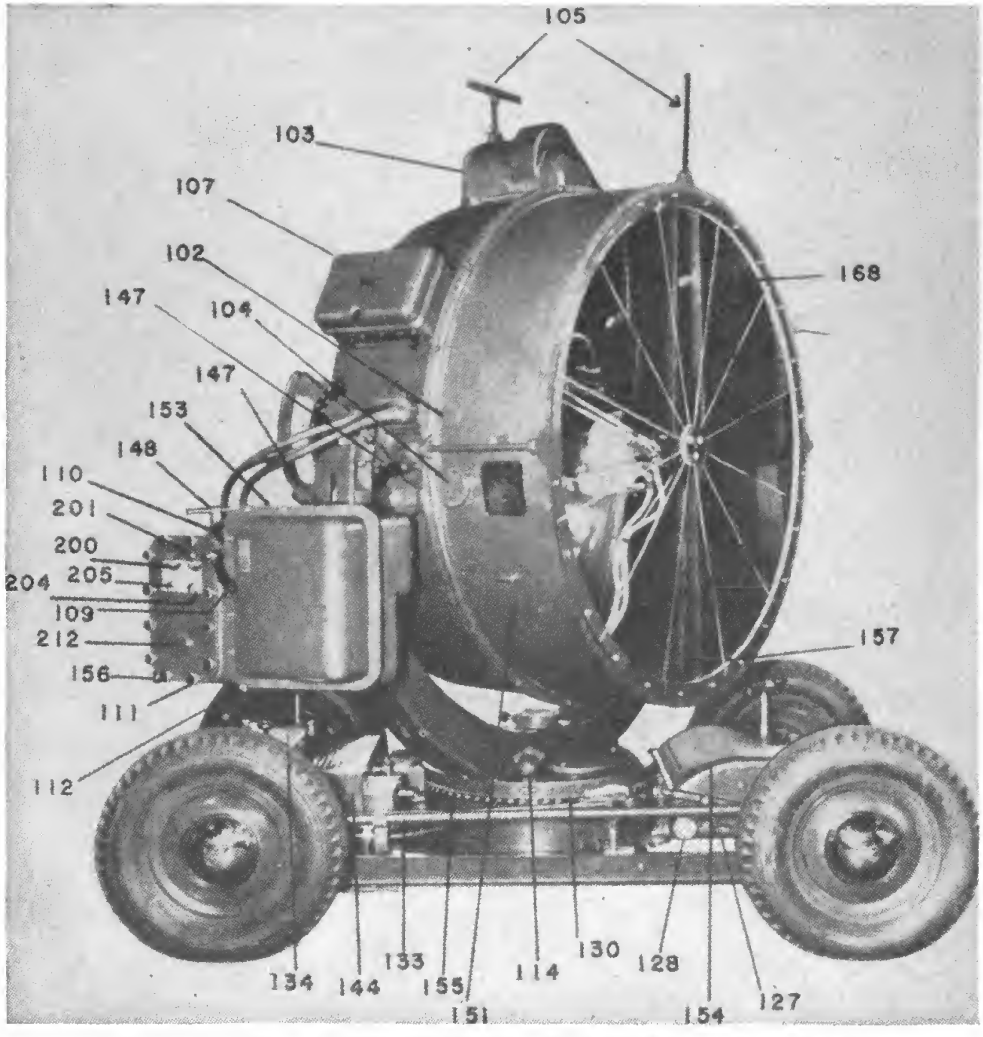


FIGURE 12.—General Electric M1940 searchlight (front quarter view).

Part	Purpose or use
102. Arc viewing window	To observe the position and condition of the arc.
103. Ventilating fan motor housing.	This houses the ventilating fan which exhausts the burned gases from the drum interior.
104. Arc image screen	This is used to check accurately the position of the positive crater. The end of the positive carbon should terminate at the black focal line. *Never allow the positive carbon to burn back beyond the red danger line.*
105. Azimuth daylight sights	For use in training. Platoon commander may check in azimuth while a target is being tracked, thus observing any error.
107. Lamp control mechanism box.	Within this box are located the various mechanisms for feeding the positive and negative carbons.
109. Elevation brake handle	For locking the searchlight at any desired elevation.
110. Extended hand control bar socket.	The extended hand control bar fits in this socket so light may be moved by hand in elevation and azimuth.
111. Recarboning lamp switch.	Light is turned on inside the drum during recarboning.
112. Scale lamp switch	This switch turns on meter, elevation scale, and azimuth scale lamps.
114. Azimuth scale lamp	To illuminate azimuth scale.
127. Azimuth clutch handle	This disconnects the azimuth D. E. C. training motor when traversing by hand.
128. Dynamotor switch	This turns on the dynamotor which converts direct current into alternating current for use in the data transmission system and for the D. E. C. system.
130. Elevation stowing rod	The searchlight drum is elevated and locked in this position by means of the stowing rod when the light is put in traveling position.
133. Towing bar	For steering the light and for towing by hand for short distances.
134. Junction box	All cables are connected to the junction box, from which place connections are made to the proper circuits.
144. Ballast resistor	This resistor is in the arc circuit. *Never change this connection except under the direct supervision of an electrical sergeant or an officer.*
147. Focusing knob	By turning this knob the lamp may be moved so that positive crater is at the focal point of mirror.
148. Extended hand control bar clamp.	This clamps the extended hand control bar in the socket.
149. Elevation scale lamp	For illuminating the elevation scale.
151. Drum access door	For entering drum for recarboning, or other purpose.
153. Elevation control box	Within this box is the D. E. C. elevation training motor and its auxiliary equipment.
154. Azimuth control box	Within this box is the D. E. C. azimuth training motor and its auxiliary equipment.
155. Azimuth scale	This scale is used when orienting the searchlight. It may be slipped around for proper setting.
156. Arc switch handle	This switch when closed allows the arc to form and a current to flow through it.
157. Counterweight	This helps to balance the searchlight on its trunnions.
168. Glass door	This glass protects the arc from wind and rain. The 12-segment construction makes it shockproof.
200. Azimuth zero reader	This is a voltmeter which has a pointer at the center of its scale. When new sound locator azimuth data are received this pointer moves away from its center (or zero) position.
201. Elevation zero reader	This is a voltmeter with a pointer at the center (or zero) of its scale. When new sound locator elevation data are received the pointer moves away from its center (or zero) position.
204. Arc ammeter	This ammeter indicates the amount of current flowing through the arc. It should read 150 amperes when the arc is operating properly.
205. Arc voltmeter	The voltmeter indicates the voltage drop across the arc. It should read 78 volts when the arc is functioning properly.
212. Dynamotor a-c indicating lamp.	A red lamp glows when the dynamotor is operating.

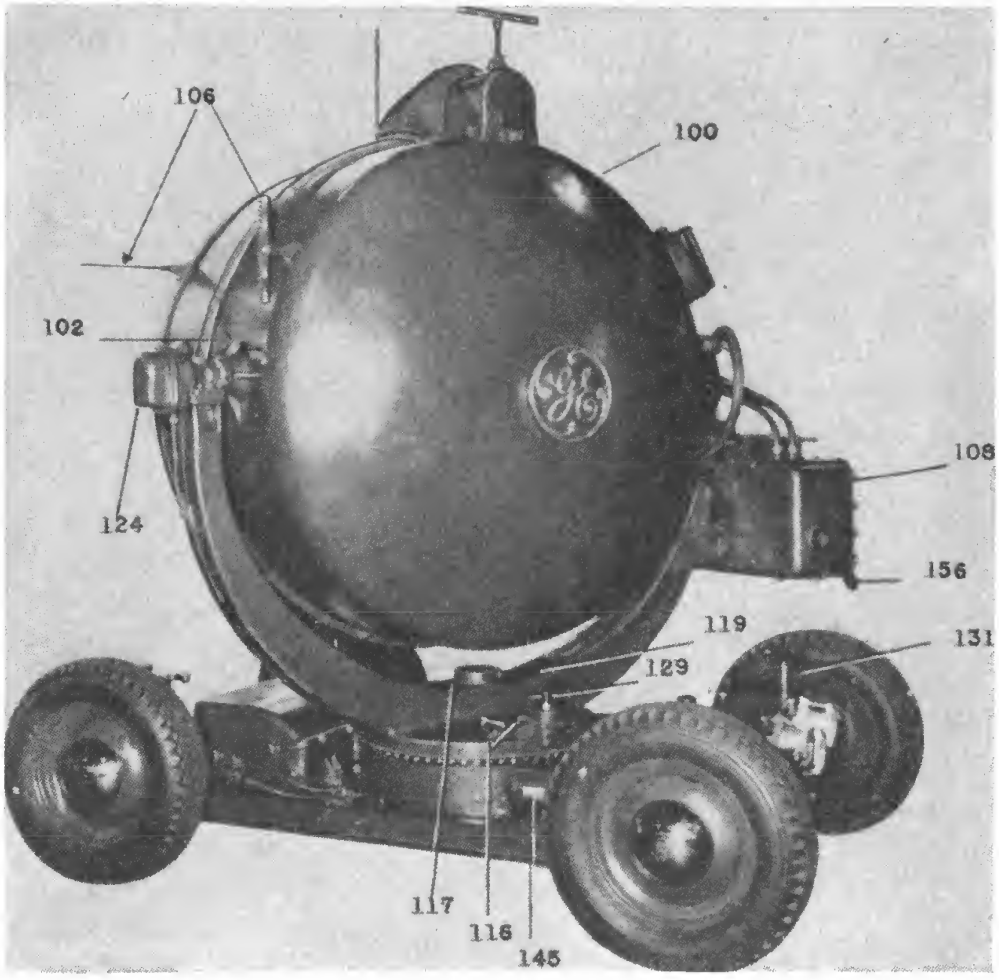


FIGURE 13.—General Electric M1940 searchlight (rear quarter view).

Part	Purpose or use
100. Drum	The drum contains the metal mirror and supports the lamp, lamp feed mechanism, and the ventilating system.
102. Arc viewing window	To observe the position and condition of the arc.
106. Elevation daylight sights.	For use in training. Platoon commander can check in elevation while a target is being tracked, thus observing any error.
108. Elevation clutch handle.	When this handle is in the hand control position the searchlight may be elevated by hand.
116. Levels	To level the searchlight.
117. Spindle cover	For access to the spindle and azimuth data receiver.
119. Azimuth correction knob.	For use when synchronizing the azimuth zero reader system.
124. Elevation data receiver cover.	This cover must be taken off to synchronize the elevation zero reader system.
129. Azimuth stowing lock	When putting the searchlight in traveling position this locks the searchlight in azimuth.
131. Leveling jacks	For leveling the searchlight.
145. Dynamotor	Converts direct current to alternating current which is used by the data transmission system and the D. E. C. system.
156. Arc switch handle	Closing this switch permits the arc to start.

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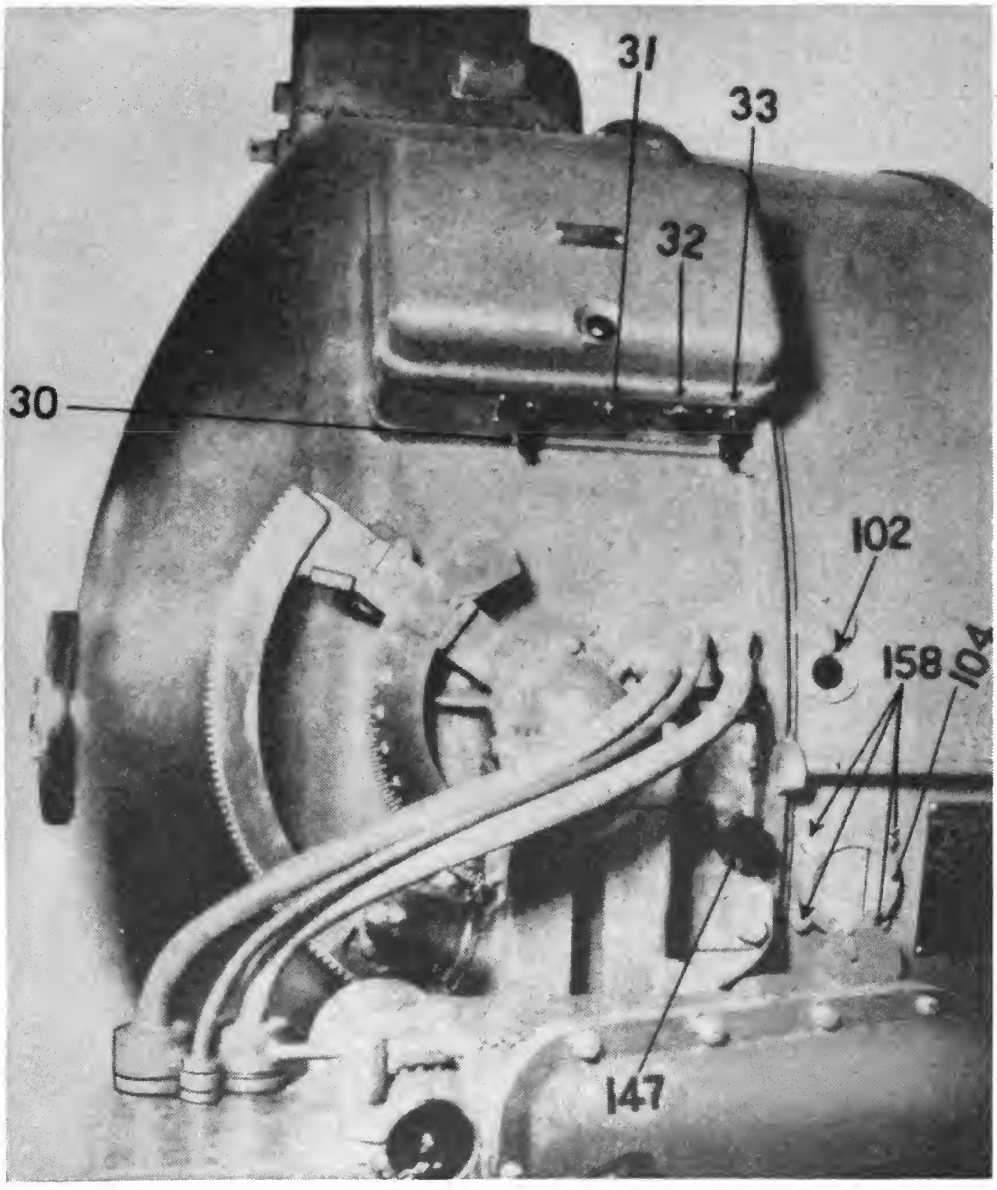


FIGURE 14. –General Electric M1940 searchlight (right upper view).

Part	Purpose or use
30. Negative carbon manual drive crank.	By pushing this crank in, the negative carbon may be fed by hand instead of automatically.
31. Positive carbon feed button.	Push button in to feed positive carbon faster. In hand operation it is worked in conjunction with part 33.
32. Positive carbon feed rate adjustment knob.	Turning this knob clockwise causes the positive carbon to feed faster.
33. Positive carbon manual drive crank.	Push in crank and turn in clockwise direction to rotate positive carbon. In hand feed it is worked in conjunction with part 31.
102. Arc viewing window	To observe the condition and position of the arc.
104. Arc image screen	This is used to check accurately the position of the positive crater. The end of the positive carbon should terminate at the black focal line. *Never allow the positive carbon to burn back beyond the red danger line.*
147. Focusing knob	By turning this knob the lamp assembly is moved so that the positive crater is placed at the focal point of the mirror.
158. Arc image adjusting screws.	These are for making a correct adjustment of the positive carbon on the image screen *by the searchlight commander.*

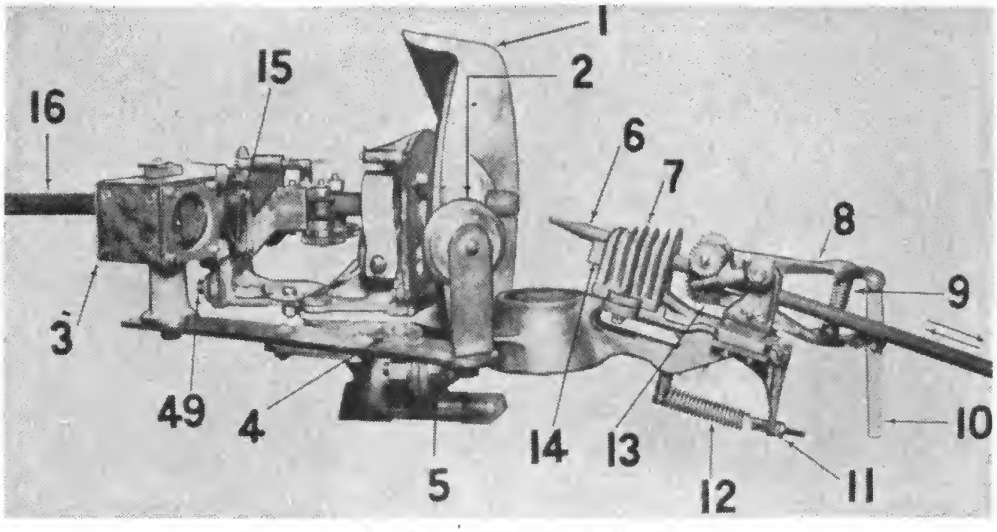


FIGURE 15.—General Electric M1940 lamp.

Part	Purpose or use
1. Obturator	This is a bronze casting to protect the positive head from excessive heat. It also prevents stray light.
2. Thermostat mirror	This mirror reflects rays of light from the positive crater onto the thermostat.
3. Thermostat	When the positive carbon burns back too far, rays of light heat up the thermostat bimetallic strip which closes a circuit. This causes the positive carbon to feed forward to its proper position.
4. Positive carbon protrusion adjusting nut.	This adjustment positions the thermostat mirror which, through the thermostat, keeps the positive carbon at its proper position, ¾ inch from positive nose.
5. Negative head mounting bolts.	Holds negative head to lamp base.
6. Negative carbon	This carbon, plus the positive carbon, allows the arc to function by having *direct current* pass through it.
7. Negative nose	Bronze casting for holding negative carbon.
8. Movable drive roller bracket.	On this bracket are mounted the upper negative feed rollers.
9. Negative carbon drive pressure spring.	This spring causes the negative feed rollers to make good contact with the negative carbon.
10. Negative carbon drive roller clamp.	Pushing this clamp to the left lifts the movable drive roller bracket so that a new negative carbon may be inserted.
11. Negative carbon brush pressure adjusting nut.	Screwing the adjusting nut farther up causes more pressure to be applied by negative brush 14 on negative carbon 6.
12. Negative carbon brush pressure spring.	This spring exerts the force which causes a pressure of the negative brush on the negative carbon.
13. Adjustable drive roller bracket.	On this adjustable bracket are mounted the lower negative feed rollers.
14. Negative brush	This brush makes a good contact with the negative carbon so current may flow through it more easily.
15. Positive carbon feed roller clamp.	This clamp is used when renewing the positive carbon. It separates the positive feed rollers.
16. Positive carbon	When the arc is operating, the positive carbon burns, causing incandescent gas to form a positive crater. From this crater comes the brilliant light for the beam.
49. Positive head mounting bolt.	This holds the positive head to the lamp base.

12. Control stations.—*Q.* Why is a control station necessary? *A.* To obtain the best "contrast" the observer must be at least 50 feet away from the searchlight beam. At this distance an electrical remote control system must be used to point the searchlight in azimuth and elevation. The control station is a part of this remote control system, and from this station the searchlight may be pointed in azimuth and elevation.

Q. What is meant by contrast? *A.* Contrast means the difference between the amount of light reflected from the target and the amount of light reflected from the illuminated sky background. The better the contrast, the better the target can be seen in the beam.

Q. In addition to being able to control the searchlight from a remote point, what other function must the control station perform? *A.* It must give an indication of sound locator data so that the searchlight may be pointed correctly. Also, the General Electric control station has a means for searching 5° around sound locator data.

Q. Name and give the functions of the various parts of the 1940 General Electric control station. *A.* See figures 16 and 17.

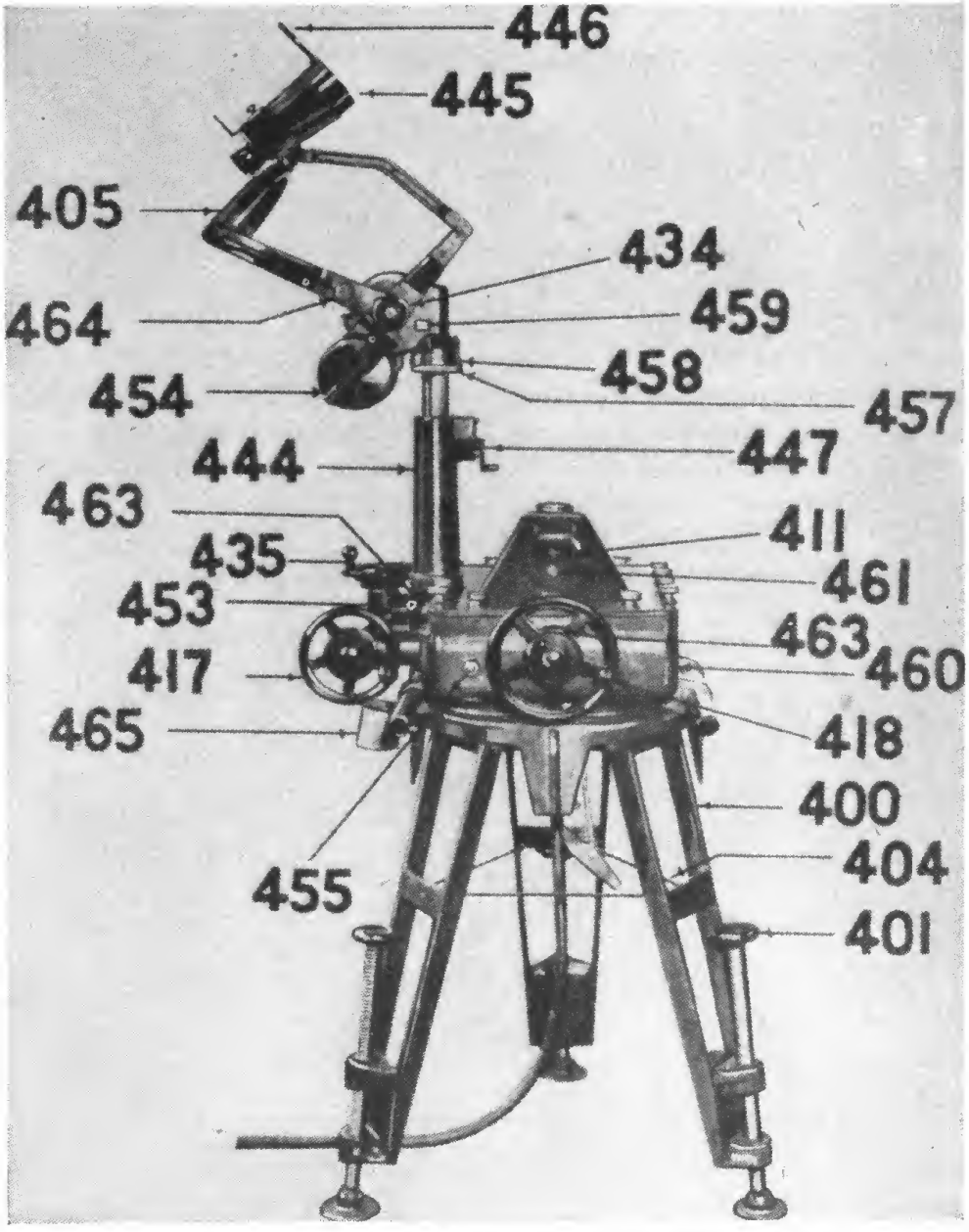


FIGURE 16.—General Electric M1940 control station (right side view).

Part	Purpose or use
400. Tripod	Controller is supported by this tripod.
401. Leveling jack	By adjusting the three jacks the control station may be leveled.
404. Tripod leg braces	To give rigidity to the tripod.
405. Binocular mount	Supports binoculars. This mount is geared to the elevation zero reader handwheel so that binoculars may be pointed in elevation according to sound locator data. It moves in azimuth as the controller moves.
411. Elevation zero indicator	This is a voltmeter whose pointer moves away from its center (zero) position as new sound locator elevation data is received.
417. Observer's elevation handwheel.	The observer uses this handwheel to track in elevation after the target is flicked.
418. Elevation zero reader's handwheel.	This handwheel elevates the binocular mount and operates the elevation D. E. C., which elevates the searchlight. This causes the pointer of the elevation zero reader to move to its zero position when the searchlight is pointed according to sound locator elevation data.
434. Binocular linkage clamp.	This clamp must be adjusted so that the elevation clutch does not allow the binocular mount to move too easily in elevation.
435. Observer's azimuth handwheel.	The observer uses this handwheel to track in azimuth when the target is flicked.
444. Binocular mount column.	This column is a support for the binocular mount.
445. Binoculars	Self-explanatory.
446. Open sight	This is used when orienting the control station and for quickly getting on an illuminated target.
447. Binocular height adjusting crank.	This allows adjustment of the height of the binocular for each individual.
453. Binocular column lock clamp.	When binocular mount is lowered in column, it is locked by pushing in this lock clamp and turning clockwise.
454. Binocular positioning handles.	By grasping these handles the binocular mount can be moved in azimuth and elevation. They are used especially to put the binocular line of sight on the searchlight beam in case the beam is not seen in the binoculars.
455. Signal switch	To signal searchlight to go in action or out of action.
457. Binocular column azimuth friction adjusting nut.	This nut is adjusted so that the binocular mount does not move too easily in azimuth.
458. Azimuth reference mark.	For use in orienting the control station in azimuth.
459. Horizontal reference mark.	For use in orienting the control station in elevation.
460. Controller box	The controller box houses all the mechanisms and supports the binocular mount.
461. Elevation zero-reader adjustment plug.	Loosen the plug and, with a small screw driver, turn voltmeter pointer adjusting screw until pointer is zeroed.
463. Level	To be used when leveling the control station.
464. Linkage pin	This pin must be in place so that the binocular mount operates properly.
465. Column socket cover	When binocular mount is disassembled, this cover is screwed over the opening in the controller box.

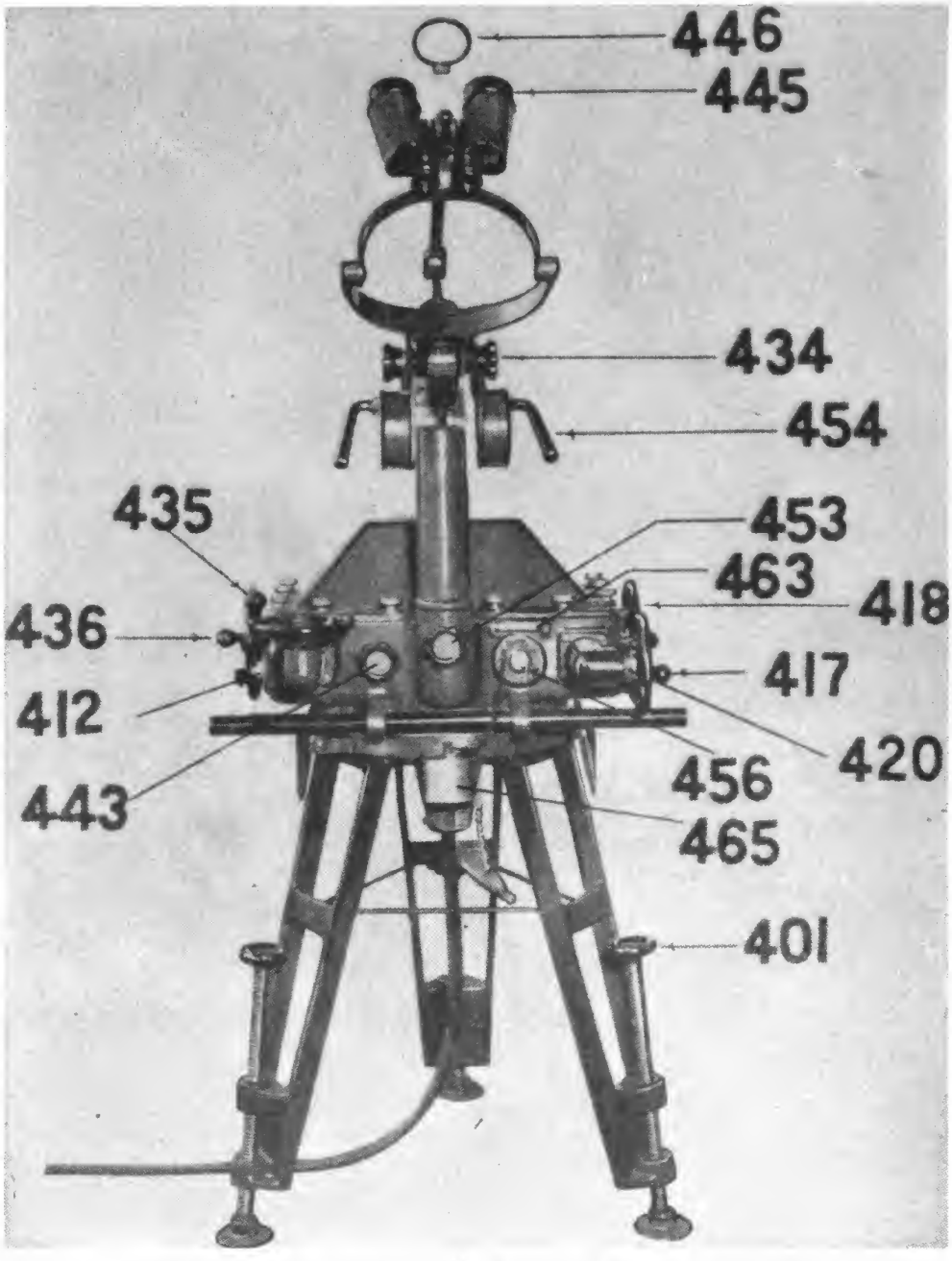


FIGURE 17.—General Electric M1940 control station (rear view).

Part	Purpose or use
401. Leveling jack	See figure 16.
412. Scale lamp switch	To provide illumination for the zero readers.
417. Observer's elevation handwheel.	See figure 16.
418. Elevation zero reader's handwheel.	See figure 16.
420. Handwheel friction clutch.	To prevent damage to the elevation mechanism.
434. Binocular linkage clamp	See figure 16.
435. Observer's azimuth handwheel.	See figure 16.
436. Azimuth zero reader's handwheel.	This handwheel rotates the controller in azimuth and operates the D. E. C., which traverses the searchlight. This causes the pointer of the azimuth zero reader to move to its zero position when the searchlight is pointed according to sound locator azimuth data.
443. Azimuth drive clutch knob.	With this knob in its released position the controller may be moved in azimuth when orienting without moving the azimuth zero reader's handwheel.
445. Binoculars	Self-explanatory.
446. Open sight	See figure 16.
453. Binocular column lock clamp.	See figure 16.
454. Binocular positioning handles.	See figure 16.
456. D. E. C. switch	This switch must be turned on before the D. E. C. will function.
463. Level	See figure 16.

13. Power plants.—*Q.* What difference is there between the Sperry M1941 and the General Electric M1940 power plants? *A.* Very little. The engines are the same except the Sperry runs at 1,100 rpm and the General Electric at 1,200 rpm. The generators are made by different manufacturers, but both deliver 150 amperes at 78 volts to the searchlight.

Q. What is the rating of the generator of the M1940 General Electric power plant? *A.* It is rated as follows:

Volts	*Amperes*	*Rpm*	*Kilowatts*
100	160	1,200	16.0

Q. Is the nomenclature of the Sperry and the General Electric power plants similar? *A.* Yes. Parts as shown in figures 10, 11, and 18 correspond except as follows:

(1) The General Electric tank holds 26 gallons.

(2) The General Electric tail lamp switch is located on the tail lamp.

(3) The General Electric fan is driven by a pulley from the main crankshaft.

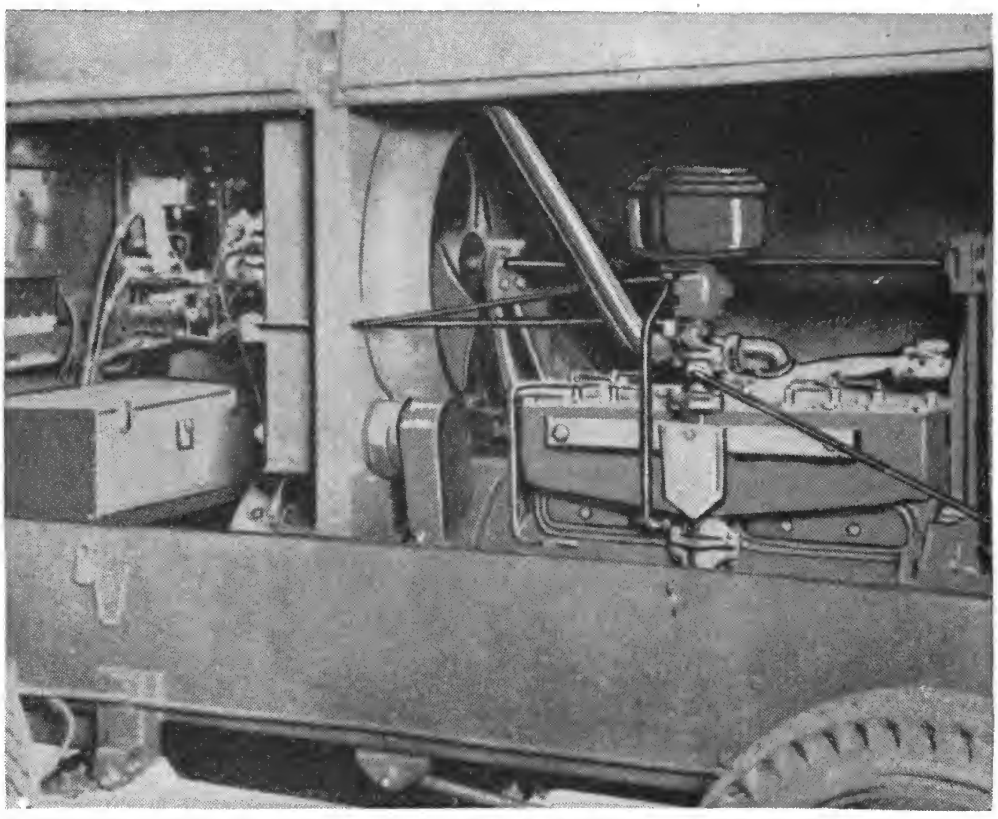


FIGURE 18.—General Electric M1940 power plant.

SECTION III

SOUND LOCATORS

14. General.—*Q.* What is a sound locator? *A.* A sound locator is an instrument which can pick up and locate accurately an airplane by means of the sound it emits.

Q. What are the two types of sound locators now in use? *A.* The M1 series sound locators and the M2 sound locator.

Q. Of what does a sound locator consist? *A.*

(1) Horns for collecting sound.

(2) Sound track to listener's helmet.

(3) Listener's helmet.

(4) A mounting for the horns so that the locator may be moved in azimuth and elevation by handwheels.

(5) An acoustic corrector to correct for sound lag.

(6) A data transmission system to send corrected data to the searchlight so it may be pointed correctly.

Q. What is meant by sound lag? *A.* Sound travels in air at about 1,100 feet per second. This means that it takes the sound coming from an airplane some time to arrive at the sound locator. During this time, or sound lag, the airplane has traveled a certain distance.

Q. What is the function of the acoustic corrector? *A.* The acoustic corrector must correct the azimuth and elevation data for the sound lag.

15. M1 series sound locators.—*Q.* What is the weight of an M1 series sound locator? *A.* 2¾ tons.

Q. How many horns are used on the M1 sound locator? *A.* Four.

Q. Are all sound locators of the M1 series similar? *A.* Yes. From the M1A1 to the M1A8, they are all identical except for minor manufacturing changes.

Q. What kind of sights are provided for orienting the M1 series sound locator? *A.* Open sights. They are to be placed on the lower elevation horn.

Q. Point out and give purpose of the parts of an M1 series sound locator. *A.* See figure 19.

Q. What acoustic correctors are used with the M1 series sound locators? *A.* The M1, M1A1, and the M2 acoustic correctors are used on the M1 series locators.

Q. How many men are required to operate the M1 series sound locator? *A.* Four men when the M1 or the M1A1 acoustic corrector is furnished. Three men when the M2 acoustic corrector is provided.

Q. What is the difference between the M1 and M1A1 acoustic correctors? *A.* The M1 has the azimuth scale graduated in degrees, the M1A1 in mils.

Q. Give the nomenclature of the M1 acoustic corrector. *A.* See figure 20.

Q. Give the nomenclature of the M2 acoustic corrector. *A.* See figure 21.

16. M2 sound locator.—*Q.* What is the weight of the M2 sound locator? *A.* 1,066 pounds.

Q. What are the six component parts for transportation of the M2 sound locator? *A.*

(1) Two horn assembly.
(2) Single horn assembly.
(3) Corrector assembly (in carrying case).
(4) Column.

(5) Platform.

(6) Cable and cable reels.

Q. Which horn is a common horn for the azimuth and elevation listeners? *A.* Upper right horn, figure 23.

Q. How many men does it take to operate the M2 sound locator? *A.* Three. The azimuth and elevation listeners and the acoustic corrector operator under supervision of the chief of section.

Q. Give the nomenclature and state the purpose or use of each part of the M2 sound locator. *A.* See figure 23.

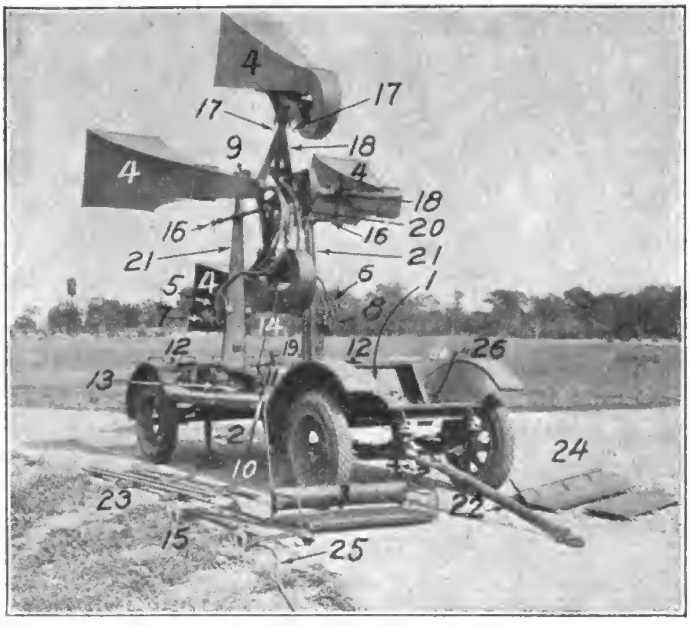


FIGURE 19.—Sound locator M1A1.

Part	Purpose or use
1. Acoustic corrector	To correct for the sound lag angle.
2. Jacks	There are four jacks for leveling the sound locator.
3. Front seat (removed)	Sound locator listeners ride on this seat during road marches.
4. Horns	These four horns collect and amplify sound. Upper and lower horns are elevation horns. Right and left horns are azimuth horns.
5. Traversing handwheel	The azimuth listener uses this handwheel to follow the airplane sounds.
6. Elevating handwheel	The elevation listener uses this handwheel to follow the airplane sounds.
7. Azimuth helmet	The two azimuth horns are connected by sound track tubing to this helmet so the listener can hear the airplane sound.
8. Elevation helmet	The two elevation horns are connected by sound track tubing to this helmet so the listener can hear the airplane sound.
9. Horn bearings	Bearings are mounted on the top of each vertical column so the horns may be elevated easily.
10. Azimuth circle	Used to orient the sound locator with the searchlight. The circle can be slipped around for adjustment.
11. Turntable	The vertical column and horn assembly are supported and turn with the turntable.
12. Seats for operators	The azimuth listener is seated on the left seat, the elevation listener on the right seat.
13. Footrest	Each listener has a footrest.
14. Adjustable locking screws.	Three screws are used to lock the turntable in azimuth for traveling on the road.
15. Horn locking frame	When the horns are mounted for traveling, this frame holds them rigidly in their traveling position.
16. Traveling horn supports.	The four horns are removed from their operating positions and put on these supports for traveling.
17. Hand clamp screws	These clamp screws lock the horns in their operating position.
18. Horn support sections	These sections support the horns in their operating position.
19. Elevation control shaft	This shafting leads from the elevation handwheel to the gears which elevate the horns.
20. Rubber tubes	These are sound track tubes conducting the sound from the horns to the listener's helmets.
21. Vertical columns	These vertical columns support the horns.
22. Towing bar	Used for towing the sound locator by its towing truck.
23. Side frames	These two frames are placed one on each side of the sound locator so that cables and other equipment will not fall off when on the road.
24. Covers for acoustic corrector.	These removable wooden covers fit over the acoustic correctors for traveling.
25. Cable leading to the control station.	Sound locator data are sent to the control station through this cable.
26. Brake handle	This operates the parking brake. The brakes are located on the rear wheels.

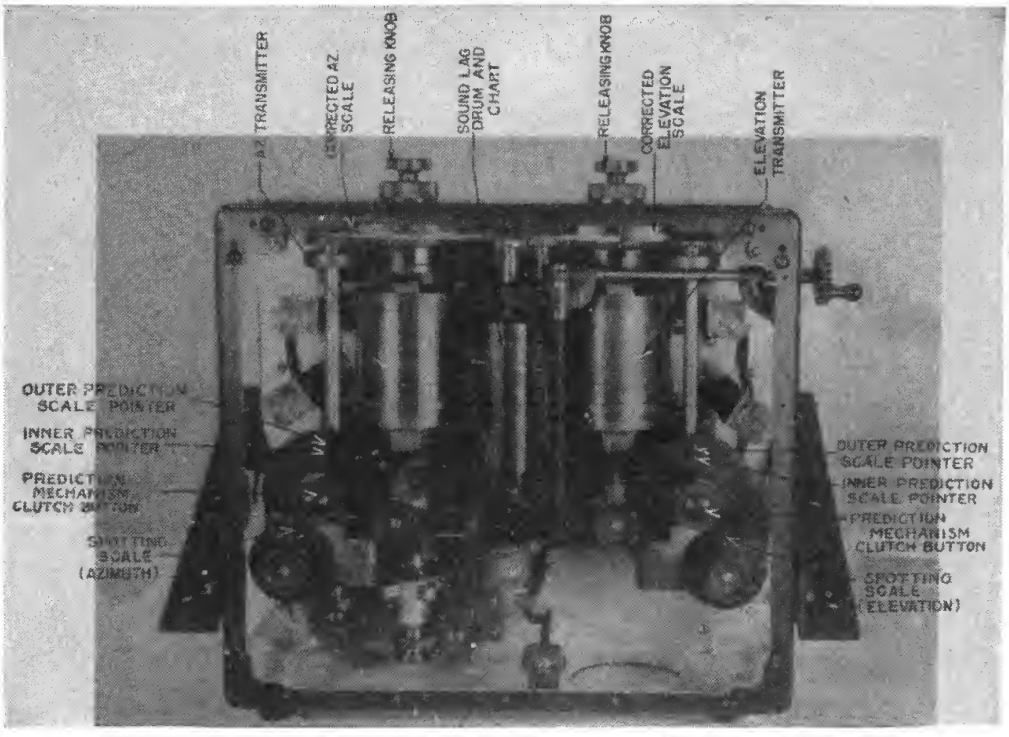


FIGURE 20.—Acoustic corrector M1.

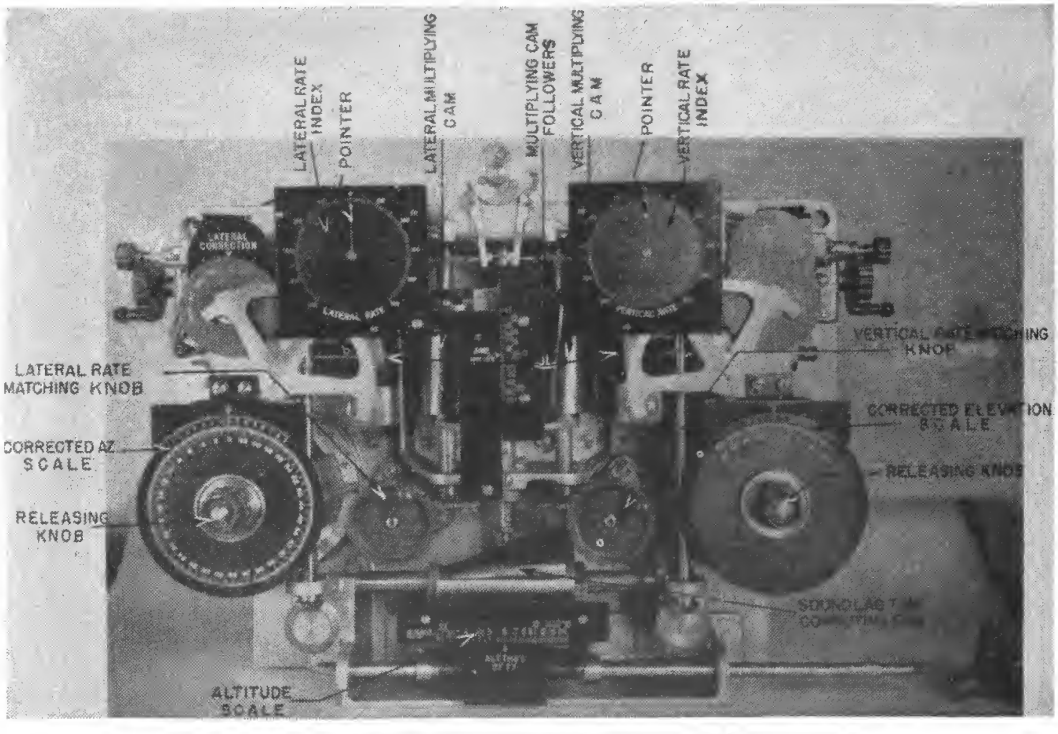


FIGURE 21.—Acoustic corrector M2.

FIGURE 22.—Corrector operator in action.

Part	Purpose or use
1. Multiplying pantograph	This causes the pantograph ball to be offset by the sound lag angle both in azimuth and elevation.
2. Target air speed setting knob.	Air speed of the target is set in on the miniature airplane which is positioned so as to be parallel to the target's course.
7. Pantograph attaching stud knob.	Holds pantograph in correct position.
8. Parallax cam	Parallax corrections are set in on the cam parallax scale.
9. Declutching gear	Push down on this gear so that the parallax arrow may be pointed at searchlight.
10. Target air speed scale	Air speed of airplane is indicated in miles per hour. Use knob (2) to set in correct air speed.
11. Pantograph pointer and ball.	The corrector operator centers the pantograph ball on the cross lines of mirror (12).
12. Mirror and cross lines	The image of the pantograph is seen in this mirror.
13. Level	To level sound locator.
14. Elevation clamp	To lock horns at any desired elevation.
15. Parallax scale	Set parallax cam to the correct figure on this scale.

Q. Point out the following parts and give the purpose or use of the part (fig. 23):

Part	Purpose or use
Elevation scale	A scale graduated in mils for elevating the horns to any desired elevation.
Sight crank handle and knob	The corrector operator uses this handle and knob to keep the pantograph ball centered in the sight mirror cross lines.
Azimuth handwheel	The azimuth listener uses this handwheel to track the sound source. There is an azimuth clamp knob on the shaft of this handwheel to lock the sound locator while orienting.
Elevating handwheel	The elevation listener uses this handwheel to track the sound source.
Azimuth scale	For use in orienting the sound locator. The scale can be moved around to any desired azimuth.
Portable lamp receptacle	For plugging in the trouble lamp.
Cable receptacle	Blue cable plug is inserted in this receptacle.
Common horn	Used to collect sound for both azimuth and elevation. (Upper right horn, fig. 23.)
Elevation horn	Used to collect sound for azimuth. (Lower right horn, fig. 23.)
Azimuth horn	Used to collect sound for azimuth. (Left horn, fig. 23.)

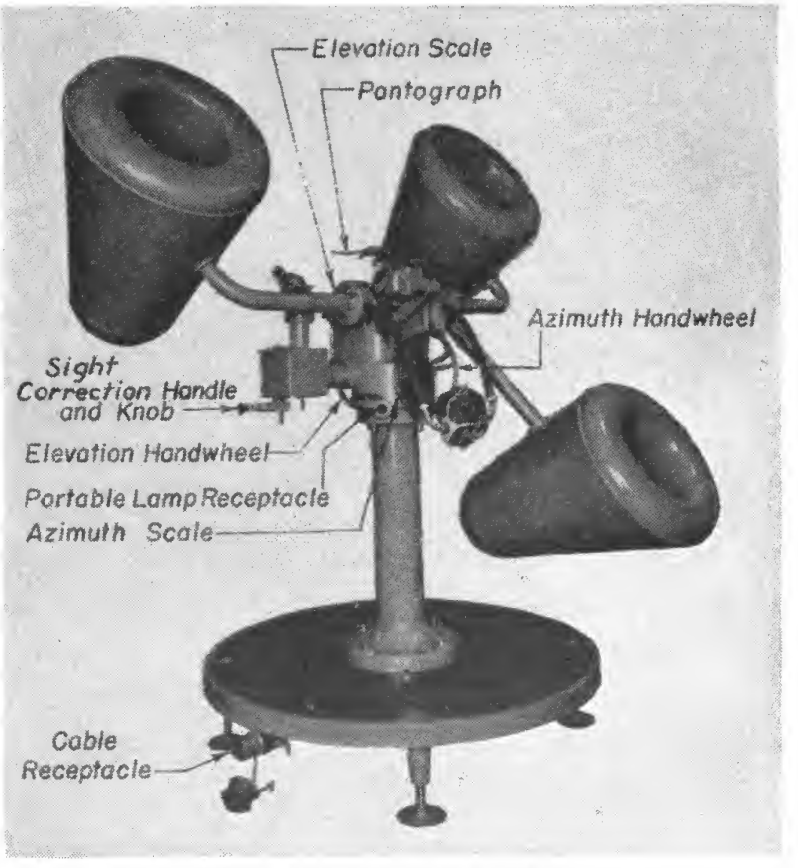


FIGURE 23.—Sound locator M2.

CHAPTER 4

CARE AND OPERATION OF SEARCHLIGHT SECTION EQUIPMENT

SECTION I

POWER PLANT

17. General.—Beginning with the M1934 portable power plant, all models are fundamentally the same. This is especially true of the Sperry power plants of 1937, 1939, 1940, and 1941, and the General Electric power plant of 1940. The M–VI and M1934 mobile power plant generators are driven by the vehicle engines through suitable transmissions.

Q. What is the principal purpose of a power plant? *A.* To furnish direct current power to operate the arc.

Q. Name the two principal parts of a power plant. *A.* A gasoline engine (1) which furnishes motive power to drive a direct current generator (2).

Q. What is the purpose of a governor on the power plant? *A.* A governor is a device on an engine which controls the fuel supply to the engine in such a way that the engine-generator speed will remain constant from no load to full load.

Q. What is supplied to control the power output of the generator? *A.* All necessary control apparatus, motors, and engine indicators mounted on a control panel.

Q. How does the engine adjust itself between "arc load" and "listening load" conditions? *A.* Automatically. The governor control sys-

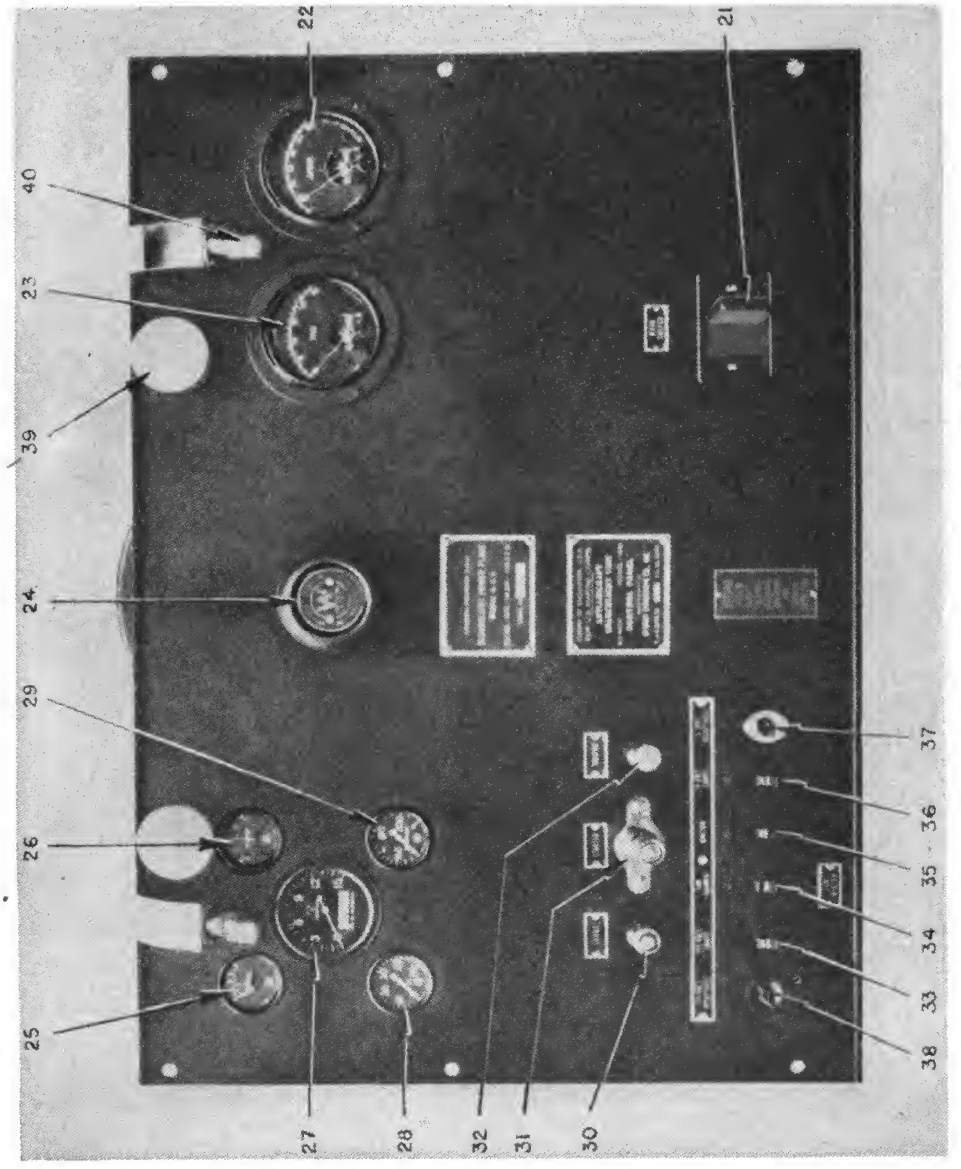
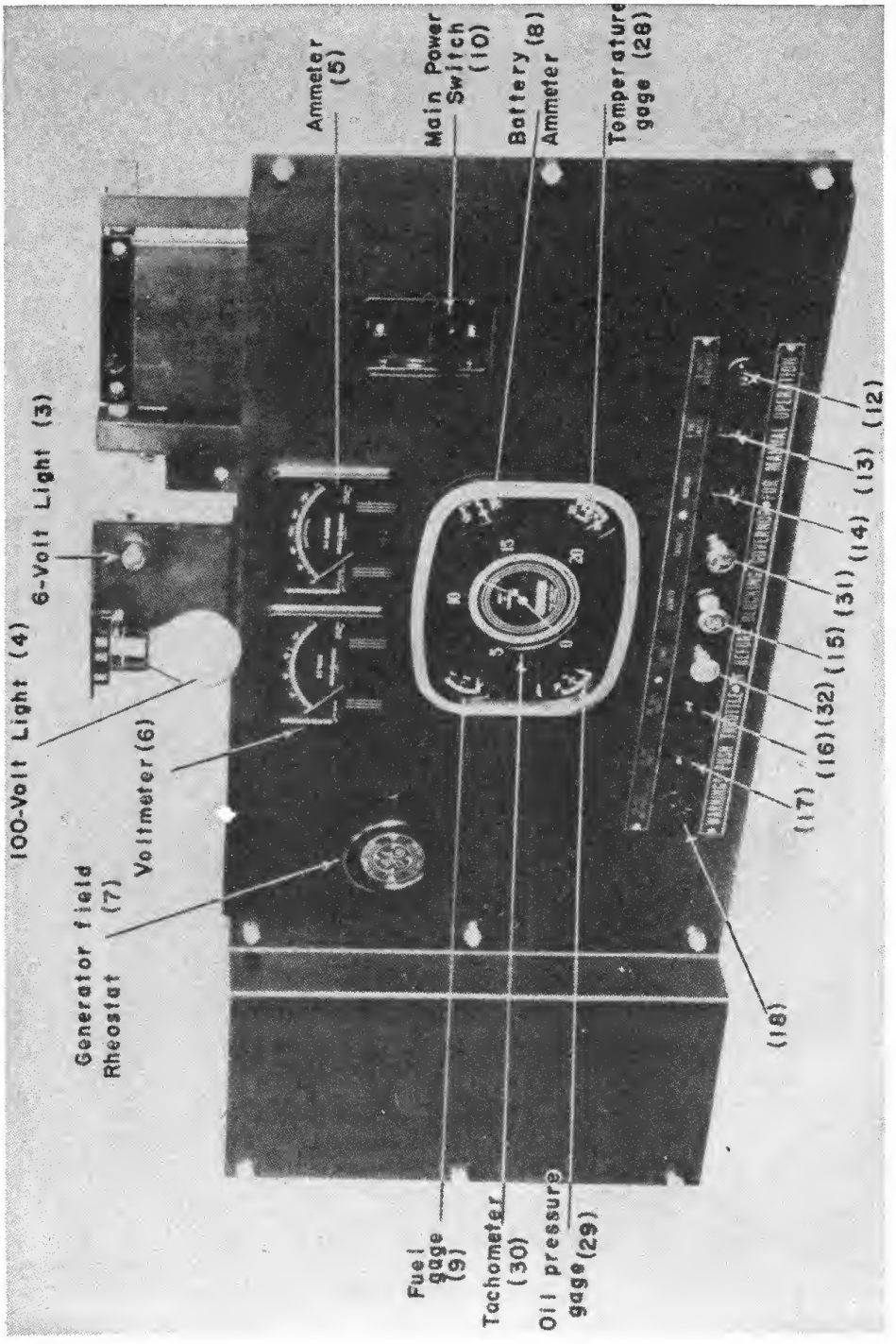


FIGURE 24.—Control panel, Sperry M1941.

21. Main switch.
22. Power ammeter.
23. Power voltmeter.
24. Voltage regulating rheostat.
25. Gasoline gage.
26. Charging motor.
27. Tachometer and revolution counter.
28. Oil pressure gage.
29. Temperature gage.
30. Choke control.
31. Starter button.
32. Throttle control.
33. 115-volt light switch.
34. Fan season switch.
35. Ignition switch.
36. 6-volt light switch.
37. 6-volt receptacle.
38. 115-volt receptacle.
39. 115-volt panel lights.
40. 6-volt panel lights.

NOTE.—Control panel for Sperry M1940 same as for Sperry M1941 except that circuit breaker is substituted for main switch.



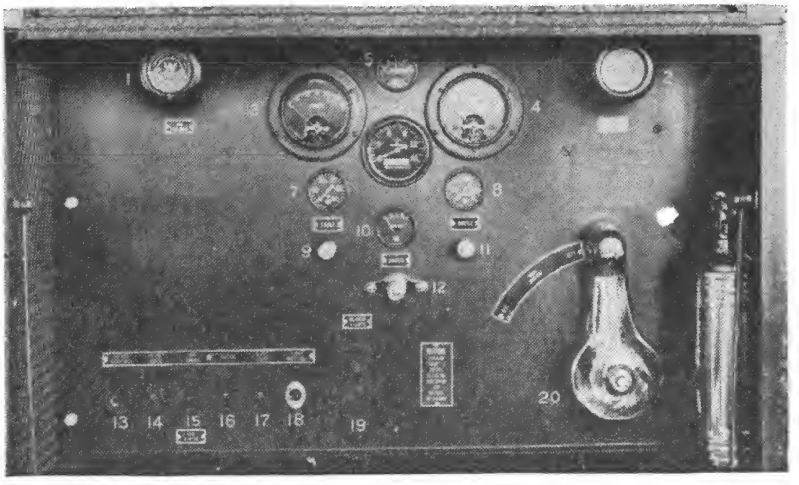
12. 6-volt receptacle.
13. 6-volt light switch.
14. Ignition switch.
15. Starter.
16. 100-volt light switch.
17. 100-volt switch.
18. 100-volt receptacle.
31. Throttle.
32. Choke.

FIGURE 25.—Control panel, General Electric M1940.

tem, having once been adjusted for arc load condition, will regulate the engine speed and maintain it at the proper speed during listening load.

Q. Should the hood doors on the power plant be open while the plant is operating? *A.* On the Sperry power plants, M1934 portable, M1937, M1939, M1940, M1941, and the General Electric M1940, the hood doors next to the radiator should be kept closed at all times while the power plant is operating. The switch board (control panel) hood door should be open. On the M–VI power plant the side hoods of the vehicle engine should be raised or taken off while the power plant is operating to drive the generator.

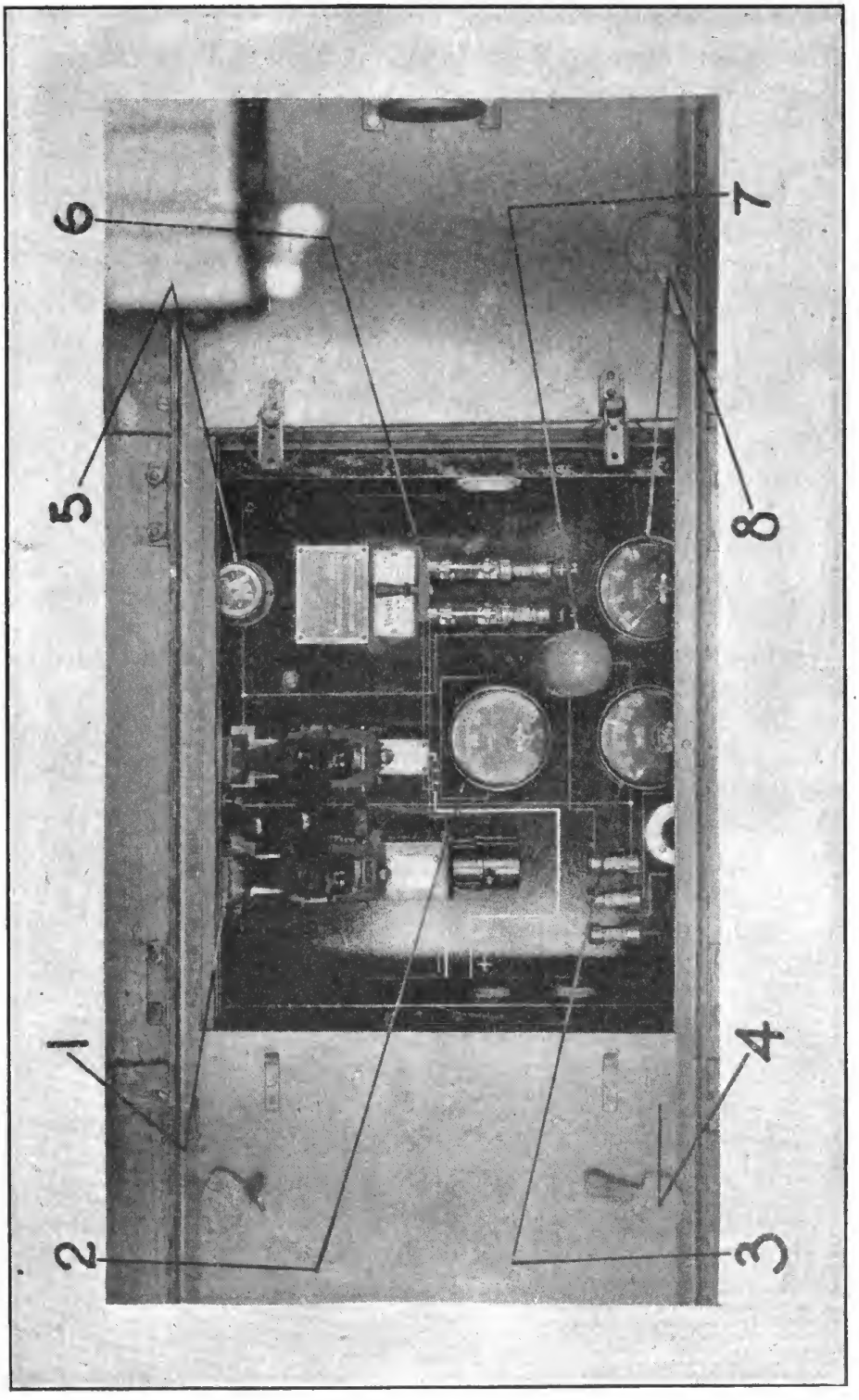
Q. On the Sperry M1934 portable, M1937, M1939, M1940, M1941, and the General Electric M1940 power plants, why is it necessary to have the hood doors next to the radiator closed while the power plant is operating? *A.* The cooling fan is located at the rear of the engine and blows the air across the engine and through the radiator. If the hood doors are left open no cooling air will pass through the radiator but will pass out through the hood door openings and will cause the engine to overheat.



1. Arc load voltage rheostat.
2. Listening load voltage rheostat.
3. Power ammeter.
4. Power voltmeter.
5. Charging ammeter.
6. Tachometer and revolution counter.
7. Oil pressure gage.
8. Temperature gage.
9. Choke.
10. Gas gage.
11. Throttle.
12. Starter button.
13. 115-volt lamp receptacle.
14. 115-volt light switch.
15. Fan season switch.
16. Ignition switch.
17. 6-volt light switch.
18. 6-volt receptacle.
19. Power voltmeter and lamp circuit breaker.
20. Main switch.

NOTE.—Control panel for Sperry M1937 same as for Sperry M1939 except that circuit breaker is substituted for main switch.

FIGURE 26.—Control panel, Sperry M1939.



1. Circuit breaker.
2. D-c ammeter.
3. D-c voltmeter.
4. Sliding door.
5. Generator field rheostat.
6. A-c switch for rotary converter.
7. Lamp.
8. A-c voltmeter.

FIGURE 27.—Power panel (control panel) M–VI (duplex truck).

18. Operation.—*Q.* What three main items should the operator check before starting the power plant? *A.*

(1) The cooling liquid in the radiator.

(2) The oil in the crankcase.

(3) The gasoline supply.

Q. How would you start the power plant? *A.*

(1) *Sperry M1937, M1939, M1940, M1941, and GE M1940.*—(*a*) Throw main switch or circuit breaker to off position.

(*b*) Pull out choke and throttle about half way.

(*c*) Start engine by turning on ignition switch and pressing starter button. After engine starts, adjust the choke for smooth operation and pull the throttle all the way out. After the engine has warmed up and has been operating smoothly for a few minutes, push the choke back in.

(2) *Portable power plant M1934.*—(*a*) Throw main switch to off position.

(*b*) Turn on ignition switch.

(*c*) Start the engine by pressing starter button and choking as required.

(*d*) When the engine warms up, decrease choking until no further choking is required.

(3) *Mobile power plant M1934.*—The engine in this case is the engine which drives the truck so its starting is similar to that of any vehicle motor.

(*a*) Open generator ventilating covers.

(*b*) Start engine and permit it to operate at idling speed.

(*c*) Close auxiliary circuit breaker.

(*d*) Disengage the truck clutch.

(*e*) Remove chain from the generator clutch lever and move lever toward the rear of the truck to the generator position.

(*f*) Put truck transmission gear shift lever in fourth gear.

(*g*) Reengage the foot clutch slowly.

(*h*) Push foot throttle down slowly to full open position and pull out the hand throttle to the full open position.

(4) *Mobile power plant, M–VI.*—The engine in this case is the engine which drives the vehicle so its starting is similar to that of any vehicle motor.

(*a*) Open ventilator covers on the generator.

(*b*) Raise both sides of engine hood.

(*c*) Open switch and circuit breaker on power panel.

(*d*) Start engine and permit it to operate at idling speed.

(*e*) Close the cut-out to the second muffler by raising the cut-out button.

(*f*) Shift the generator clutch lever to its rear (generator) position.

(*g*) Depress the engine clutch, place gear shift in high, and let out engine clutch slowly.

(*h*) Press in governor cut-out button on dash.

(*i*) Accelerate the engine by gradually advancing the hand throttle to its wide-open position. The spark lever should be fully advanced. The governor should control the speedometer speed to 23 to 27 mph.

(*j*) Regulate the voltage with the field rheostat to 100 volts.

(*k*) When the engine has been warmed up, close circuit breaker on power panel.

(*l*) Close switch to start rotary converter.

Q. How would you adjust the voltage and current? *A.*

(1) *Sperry M1940, M1941, and GE M1940.*—With the engine speed set to 1,000 rpm for Sperry M1940, 1,100 rpm for Sperry M1941, or 1,200 rpm for GE M1940 under arc load condition, the following procedure should be observed:

(*a*) With the searchlight arc burning, adjust the voltage regulating rheostat so that the ammeter at the *searchlight* indicates the proper arc current, approximately 150 amperes. The voltmeter at the power plant should then indicate approximately 100 volts, and the ammeter at the power plant should indicate approximately 162 amperes (160 amperes on the GE M1940).

(*b*) Voltage and current adjustment should be made with the arc load on.

(2) *Sperry M1937 and M1939.*—The governor and generator voltage control equipment has two operating positions, listening load and arc load. Therefore two separate rheostats are provided.

(*a*) At listening load speed (875 to 900 rpm) the listening load rheostat should be adjusted so that the generator delivers 10 to 15 amperes at 100 to 110 volts.

(*b*) At arc load speed (1,200 rpm) the arc load rheostat should be adjusted so that the generator delivers 165 amperes at 100 volts.

(3) *M1934 portable.*—(*a*) Set the voltage manual rheostat on the painted marks. This rheostat controls the voltage directly when the voltage regulator and electrical governor are disconnected. Under automatic operation, the proper setting of this rheostat is necessary so that the engine will run at the proper speed while generating the proper voltage.

(*b*) Set the voltage automatic rheostat on the painted marks. This rheostat provides a fine adjustment of the voltage by changing the setting of the voltage regulator.

(*c*) With the rheostats set on the painted marks as indicated, the generator should develop approximately 100 volts at approximately 850 rpm with a hot engine. If this operating condition is obtained, it will indicate that the electrical governor is functioning. It may be necessary to shift the rheostat settings very slightly to obtain the above desired values. After these settings are made, no further adjustments of the rheostats will normally be required while operating the searchlight.

(4) *M1934 mobile.*—The M1934 mobile power plant has incorporated in it an automatic voltage regulator which maintains approximately constant voltage regardless of current fluctuations. The desired voltage is set by the voltage adjustment rheostat, located on the upper right hand side of the control panel. The knob of the rheostat is turned clockwise to increase the voltage and counterclockwise to decrease the voltage. The normal operating voltages are 98 volts with 150 amperes arc load, and 101 volts with a listening load speed of 900 rpm.

(5) *M–VI.*—With the searchlight in operation, and the power plant running at a speedometer speed of 25 mph, adjust the generator field rheostat so that the voltage of the generator is 100 volts. The ammeter should then indicate approximately 150 amperes.

Q. In case of an emergency, how would you manually control the engine speed and voltage? *A.*

(1) *Sperry M1941, M1940, and General Electric M1940.*—(*a*) The first precaution is to make certain that the governor arm is blocked (tied) in the forward position to prevent interference from the governor itself.

(*b*) With throttle adjusted to a setting of approximately normal arc-load speed, start engine, allow it to warm up, and then strike the arc. Adjust the throttle until the tachometer indicates normal arc-load speed with the arc burning.

(*c*) If required, adjust the voltage regulating rheostat until the ammeter indicates the proper current.

(*d*) When the arc is cut off, the throttle at the power plant must be readjusted immediately to prevent overspeeding and excessively high voltages.

NOTE.—Do not readjust the voltage regulating rheostat after it has once been adjusted for arc load.

(2) *Sperry M1939 and M1937.*—(*a*) Block the governor arm in the forward position (tie it) to prevent interference from the governor.

(*b*) Set the throttle at listening speed. When the arc is struck, adjust the throttle to obtain the normal arc-load speed.

(*c*) When changing from arc load to listening load, quickly push in the throttle simultaneously with the removal of arc load to decrease engine speed. This must be done to avoid overspeeding and excessively high voltage.

(*d*) If engine speed adjustments are carefully made it will be unnecessary to change settings of listening-load rheostat or arc-load rheostat when changing from one speed to the other.

(3) *M1934 portable.*—The voltage and speed may be manually controlled should the electrical governor or regulator fail.

(*a*) Normally, on failures or opening of the electrical governor circuit, the electrical throttle will return to and remain at the wide-open position. If this does not happen, disconnect one lead of "voltage automatic" rheostat.

(*b*) Release mechanical governor thumb nuts to permit the rod to go to limit of its travel into the panel.

(*c*) Turn voltage manual rheostat to the extreme clockwise position.

(*d*) Pull out mechanical governor rod and lock it at the no-load speed of 1,150 rpm.

(*e*) Adjust voltage manual rheostat until the no-load voltage is 110 volts.

(*f*) When the arc is struck, adjust voltage manual rheostat to 98 volts when searchlight arc is drawing 150 amperes.

(*g*) When changing from arc load to listening load quickly readjust voltage manual rheostat to 110 volts.

(*h*) If the voltage regulator fails, remove front of the panel and block regulator in the closed position. The engine speed may then be adjusted and maintained approximately correct by manual control of the throttle. When the arc load is removed, immediately push in throttle to decrease engine speed in order to prevent overspeeding and excessively high voltages.

(4) *M–VI.*—(*a*) Block governor arm (tie it) so that the butterfly valve on the carburetor is in the open position.

(*b*) The engine speed may then be adjusted and maintained approximately correct by manual control of the throttle.

(*c*) When the arc load is removed, immediately push in throttle to decrease the engine speed in order to prevent overspeeding and excessively high voltages.

Q. What should you do if the governor rod or governor arm should break? *A.* Wire the valve lever that goes to the carburetor so as to hold the butterfly control valve in the open position. The power plant may then be manually controlled.

Q. How would you stop the power plant? *A.*

(1) *Sperry M1941, M1940, M1939, M1937, and General Electric M1940.*—(*a*) Throw main switch (21) to the "off" position.

(*b*) Push throttle all the way in to allow the engine to slow down to idling speed.

(*c*) Turn ignition switch (35) to "off" position. If the ignition switch is turned off before engine has slowed down to idling speed, it will backfire and probably damage the exhaust stack or muffler or both.

(2) *Sperry M1934 portable.*—(*a*) Open main circuit breaker.

(*b*) Turn off ignition switch.

(3) *M1934, mobile.*—(*a*) Open main circuit breaker.

(*b*) Close throttle.

(*c*) Disengage clutch.

(*d*) Put truck transmission gear shift lever in neutral.

(*e*) Move generator clutch lever to truck position and fasten it with safety chain.

(*f*) Remove foot from clutch.

(*g*) Open auxiliary circuit breaker.

(*h*) Close generator ventilating covers.

(4) *M–VI.*—(*a*) Open circuit breaker.

(*b*) Decelerate engine by gradually closing the hand throttle.

(*c*) Pull out governor cut-out button on the dash.

(*d*) Depress engine clutch and place the gear shift in neutral.

(*e*) If the power plant is not to be operated again immediately, the operator should then shift the generator clutch lever to its forward position, open the contact to the second muffler, stop the engine, lower and clamp the covers on the engine hood, and lower and clamp the generator port covers.

19. Care of power generator.—*Q.* Should mechanisms and bearings be overlubricated? *A.* No. Never overlubricate as it may cause much trouble, especially around electrical apparatus.

Q. Is more grease required in the Tropics than in cold climates? *A.* Yes. However, be careful not to overlubricate.

Q. Should the commutator be lubricated? *A.* No. The brushes contain sufficient graphite to maintain proper lubrication.

Q. How are the generator bearings lubricated? *A.*

(1) *Sperry M1941, M1940, M1939, and M1937.*—The armature is supported at the commutator end by a sealed or cartridge type of ball bearing. The grease is provided in the bearing at the factory and will give adequate lubrication for three years of normal service. It is recommended that when the engine is reconditioned the grease in this bearing be examined. If the grease is discolored or has a bad odor, the bearing should be cleaned and repacked with new ball-bearing grease of the type furnished for this purpose. Be very careful not to overlubricate.

(2) *General Electric M1940 and M1934 portable.*—The bearing at the commutator end is provided with a grease cup. A soft grade of grease should be used. Be careful not to overlubricate because the bearing will overheat and the grease may leak past the seal into the generator. The amount of grease added must be determined by experience.

(3) *M1934 mobile and M–VI.*—There are three distinct rotating members included in the generator: armature, propeller shaft, and tail shaft. Each of these units is supported on two antifriction bearings. The bearings for the armature and propeller shaft at the commutator end should be lubricated with a soft grease by means of the fittings provided. Be careful not to overlubricate. The remaining bearings are lubricated with oil (SAE No. 70) from the clutch housing.

20. Care of engine.—*Q.* How can the amount of oil in the crankcase be determined? *A.* By means of an oil gage rod or dip stick.

Q. What oil should be used? *A.* In summer, SAE No. 30 is recommended for normal operation. For heavy-duty operation in summer, SAE No. 40 may be used. In winter, use SAE No. 10W. (All Navy specifications.)

Q. Why should the filler cap be on the filler pipe at all times, except when refilling the engine with oil? *A.* With the filler pipe open, the breathing action of the engine will draw dust and dirt into the engine, causing rapid wearing of the cylinder walls and bearing surfaces.

Q. How often should valves be ground and carbon cleaned from the engine? *A.* If instructions as given are followed carefully, the valves will seldom require grinding and little carbon will be formed. *Watch the oil and gasoline for impurities.*

Q. How often should the oil pan be removed? *A.* Every 6 months so that the oil screen may be cleaned.

Q. Should the carburetor be adjusted frequently? *A*. No. Very often the trouble is caused by dirty gasoline or by water in the gasoline.

Q. How often should the gasoline filter be cleaned? *A*. Whenever there is any sediment present, or when there is a noticeable amount of water in the glass bowl of the filter.

Q. Should the distributor points be checked? *A*. Yes. Check frequently to see that they are clean and making good contact without unnecessary sparking. If pitted, clean with No. 00 sandpaper.

Q. How often should the radiator be cleaned? *A*. At least twice a year, usually in the spring and in the fall. Use ½ pound sal soda and ½ pint kerosene per gallon of water. Fill the radiator with this solution and run the engine for 3 or 4 hours, then flush out thoroughly with clear water, using at least two changes of clear water before filling the radiator for normal operation.

Q. Where can you find instructions for adjusting the various parts, replacements, and trouble shooting? *A*. Refer to the Operator's Manual furnished with your power plant. *Follow instructions exactly.*

21. Lubrication schedule of main parts of searchlight power plants.

	Sperry 1941, 1940, 1939	General Electric 1940	Sperry 1937	Portable 1934	Mobile 1934 and M–VI
Engine					
Engine oil change	Every 3 months, or every 30,000 "hundreds" revolutions of the engine.				1,000 miles.
Chassis	3 months	3 months	3 months	3 months	Do.
Fan bearings	6 months	6 months	6 months	6 months	Do.
Water pump	Weekly	Weekly	Weekly	Weekly	Do.
Governor and throttle linkages	do	do	do	do	Do.
Sidedoor hinges	do	do	do	do	
Carburetor	do	do	do	do	Do.
Charging generator	Monthly	Monthly	Monthly	Monthly	Do.
Starting motor	do	do	do	do	Do.
Distributor	do	do	do	do	Do.
Magneto			Yearly	Yearly	
Electrical governor				2 months	
Trailer				1,000 miles	
Generator					
Main bearing	3 years	Monthly	Monthly	Monthly	5,000 miles.
Tachometer drive	3 months	3 months	3 months	3 months	

MAINTENANCE SCHEDULE

	Sperry 1941, 1940, 1939	General Electric 1940	Sperry 1937	Portable 1934	Mobile 1934 and M-VI
Engine					
Air cleaner	Weekly	Weekly	Weekly	Weekly	1,000 miles.
Oil filter, renewed	When black streaks begin to appear in the oil.				Clean every 1,000 miles.
Oil screen, cleaned	6 months	6 months	6 months	6 months	
Radiator, cleaned	do	do	do	do	5,000 to 10,000 miles.
Fan motor, cleaned	3 months		3 months	3 months	
Battery	Weekly	Weekly	Weekly	Weekly	Weekly.
Distributor points	Monthly	Monthly	Monthly	Monthly	Monthly.
Magneto			do	do	
Generator					
Cleaned	3 months	3 months	3 months	3 months	3 months.
Brushes, checked	do	do	do	do	Do.

NOTE.—Above schedule is based on normal or average conditions; in some cases more frequent maintenance and lubrication may be necessary, as will be determined by experience.

For detailed maintenance and lubrication consult the Operator's Manual furnished with each power plant.

SECTION II

SEARCHLIGHT

22. General.—*Q.* What should the searchlight operator know about the searchlight? *A.* He should know the nomenclature of the searchlight for second class gunner's instruction as given in paragraphs 8, 9, 11, and 12. In addition he must know the operation and care of the searchlight.

Q. How is the power transmitted from the power plant to the searchlight? *A.* Through two single-conductor cables. The plugs and receptacles are painted yellow.

Q. What is the normal current and voltage of the arc? *A.* The arc should operate with a current of 150 amperes and a voltage of 78 volts.

Q. What is the relation between the arc length, arc voltage, and arc current? *A.*

(1) The arc voltage varies directly as the arc length.
(2) The arc current varies inversely as the arc length.

Q. What are the dimensions and burning time of the carbons? *A.*

Carbon	*Size*	*Burning time (approximately)*
Positive ---	22 inches by 0.633 inch outside diameter	1½ hours
Negative---	12 inches by 0.434 inch outside diameter	1½ hours

Q. When recarboning should you use new carbons? *A.* Yes, always use a pair of full length carbons.

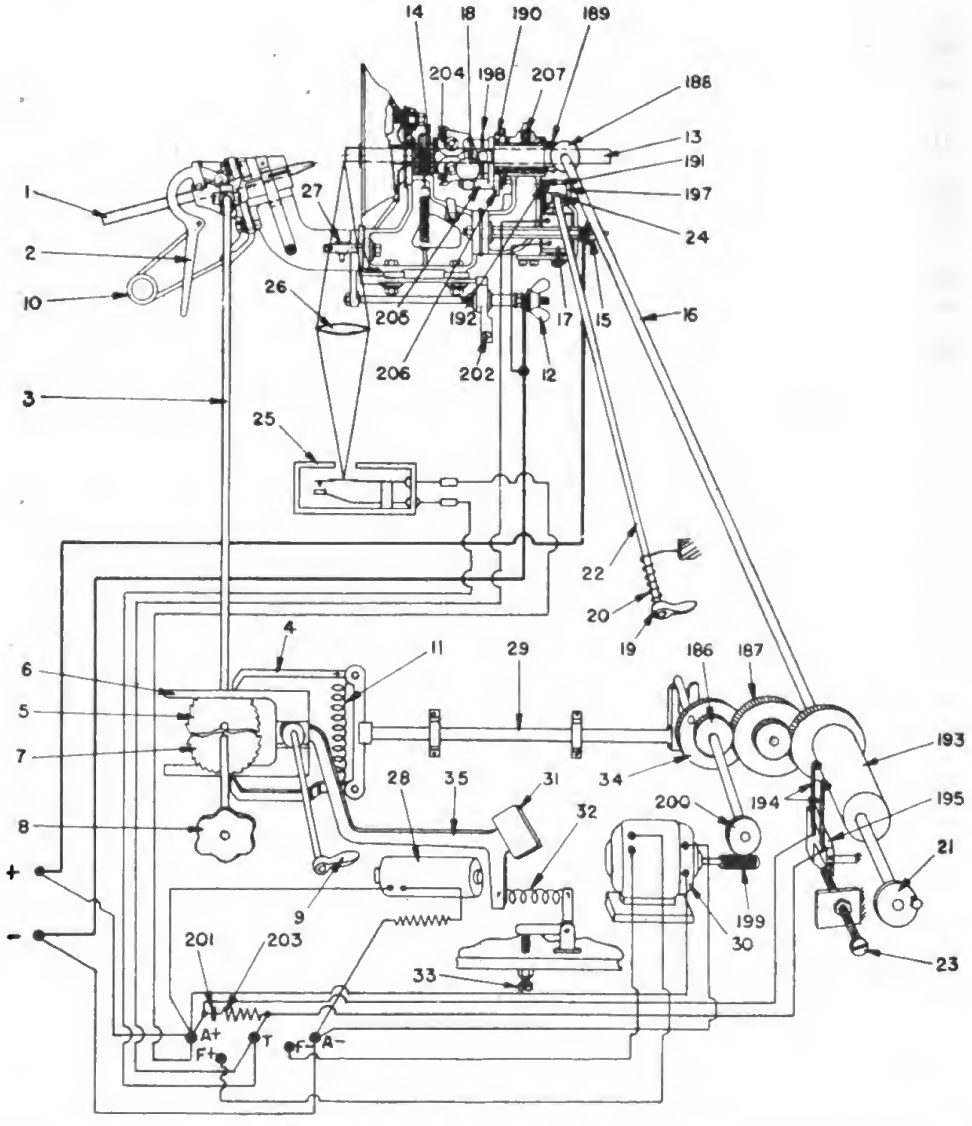


FIGURE 28.—Schematic diagram of the Sperry M1941 lamp and lamp control mechanism.

1. Negative carbon.
2. Negative release lever.
3. Negative control rod.
4. Negative feed pawls.
5. Negative feedback ratchet.
6. Pawl guards controlling negative feed.
7. Negative feed forward ratchet.
8. Negative hand feed knob.
9. Negative feed centralizer lever.
10. Negative carbon release spring.
11. Negative feed pawl spring.
12. Negative terminal.
13. Positive carbon.
14. Positive contact.
15. Positive terminal.
16. Positive control rod.
17. Positive feed control electromagnet.
18. Positive feed gear.
19. Positive hand feed lever.
20. Positive hand feed lever spring.
21. Positive hand feed handwheel.
22. Positive feed shaft.
23. Positive feed rate adjustment screw.
24. Positive feed shaft pin and spring.
25. Thermostat.
26. Thermostat lens.
27. Lens positioning screw.
28. Arc length control coil.
29. Reciprocating feed member.
30. Feed motor.
31. Counterbalance.
32. Adjustment spring.
33. Arc length adjustment screw.
34. Eccentric disk.
35. Balanced armature.
186. Eccentric shaft gear.
187. Gear train.
188. Driving miter gear.
189. Driven miter gear.
190. Ratchet and positive feed gear assembly.
191. Spring loaded feed plunger.
192. Plunger spring.
193. Eccentric cam.
194. Roller arm contacts.
195. Switch.
197. Plunger operating armature.
198. Recarboning key.
199. Worm.
200. Worm wheel.
201. Condenser.
202. Focusing bracket set screw.
203. Resistor.
204. Positive carbon feed rollers.
205. Yoke.
206. Planetary gear.
207. Main positive feed bearing.

23. Operation of lamp and lamp control mechanism, M1941 Sperry searchlight.—*Q*. Describe briefly the operation of the lamp control mechanism. *A*. The lamp control mechanism and lamp are shown in schematic form in figure 28.

(1) *Positive carbon feed system.*—The feed motor (30) drives, through a set of gears, the positive rod (16) which drives miter gear (188) and a driven miter gear. Miter gear (189) drives a yoke carrying with it a set of gears. This set of gears includes a ratchet and gear assembly (190) which, when prevented from rotating by a feed plunger (191), causes a planetary gear (206) to rotate, which in turn causes the feed rollers to rotate, thus feeding the positive carbon forward.

(2) *Negative carbon feed system.*—The negative carbon feed system operates as follows: The feed motor (30) drives through eccentric gear (186), which in turn causes the reciprocating feed member (29) and the feed pawls (4) to oscillate back and forth. One of the feed pawls (4) (depending upon the position of the negative feed control guard (6) drives the negative control rod (3) so as to feed the negative carbon forward. The other pawl (4) drives the control rod in the opposite direction so as to retract the negative carbon. The negative control rod (3) is connected to the feed rollers which position the negative carbon.

Q. What operates the positive feed plunger (191), figure 28? *A*. An electromagnet which may be energized from two sources: a cam operated switch (195) or thermostat (25).

Q. What is the purpose of the thermostat? *A*. The positive carbon burns back twice as fast as the normal rate of feed, therefore the thermostat functions to give the positive carbon an additional forward feeding to keep the luminous ball of vapor at the focal point of the mirror.

Q. How does the thermostat function? *A*. It is a thin strip of two different metals welded into a single strip. When heated this strip will bend because the two metals have different rates of expansion. When rays of light from the positive crater are focused by the thermostat lens (26) on to the bimetallic strip, the strip bends and closes an electrical contact which in turn energizes the positive feed electromagnet.

Q. What is the function of the arc length control coil (28)? *A*. It acts as a magnet on armature (35), which in turn positions negative feed pawl guard (6), allowing ratchet (5) to retract the negative carbon when the arc voltage is less than 78 volts. Ratchet (7) is engaged when the voltage is greater than 78 volts. Thus it keeps the negative carbon positioned so as to maintain a constant arc length. It functions on the electrical principle that the arc voltage varies directly with the arc length.

24. Operation of lamp and lamp control mechanism, M1940 Sperry searchlight.—(M1939, M1937, M1934, and M–VI are similar.)

Q. Describe briefly the operation of the lamp control mechanism. *A*. The control mechanism and lamp are shown in schematic form in figure 29.

(1) *Positive carbon feed system.*—The feed motor (30) drives an eccentric disk (34) causing the reciprocating feed member (29) and positive feed pawl (20) to move back and forth. Positive feed pawl (20) engages the teeth on positive feed ratchet (18), rotating it and the positive control rod (16) in a counterclockwise direction. Control rod (16) drives gear (36), causing a yoke carrying planetary gear (38) to rotate. Planetary gear (38), through a worm drive, causes the carbon feed rollers to rotate and feed the positive carbon forward.

(2) *Negative carbon feed system.*—The reciprocating feed member (29) and the feed pawls (4) oscillate back and forth. One of the feed pawls (4) (depending upon the position of the negative feed control guard (6)) drives the negative control rod (3) so as to feed

the negative carbon forward. The other pawl (4) drives the control rod in the opposite direction so as to retract the negative carbon. The negative control rod (3) is connected to the feed rollers which position the negative carbon.

Q. What is the normal current and voltage of the arc? *A*. The arc should operate with a current of 150 amperes and a voltage of 78 volts.

Q. What is the function of the positive feed control guard (19)? *A*. Raising the positive feed control guard permits more teeth on the positive feed ratchet (18) to be engaged by positive feed pawl (20), thereby increasing the rate of feeding of the positive carbon. The opposite condition occurs when the guard (19) is lowered. The normal position of the positive feed control guard (19) is such as to allow the positive feed pawl (20) to engage only 1 tooth on the positive feed ratchet (18) for each stroke of the feed pawl.

Q. What actuates the positive feed control guard (19)? *A*. The positive feed control guard can be positioned, automatically or manually, as follows:

(1) *Manually*.—By turning the positive feed rate adjustment knob (23), the position of the positive feed control guard (19) can be controlled, and therefore the rate of feeding of the positive carbon.

(2) *Automatically*.—The positive feed control electromagnet, when energized, will raise the positive feed control guard (19), thereby increasing the feeding of the positive carbon.

Q. What energizes the positive feed control electromagnet (17)? *A*. The closing of the contacts of the bimetallic strip in the thermostat (25).

Q. How does the thermostat function? *A*. The thermostat consists of a thin strip of two different metals welded into a single strip. When heated these strips will bend because the two metals have different rates of expansion. When rays of light from the positive crater are focused by the thermostat lens (26) on to the bimetallic strip, the strip bends and closes an electrical contact which in turn energizes the positive feed electromagnet, causing the positive crater to return quickly to the focal position.

Q. What is the function of the arc length control coil (28)? *A*. It acts as a magnet on armature (35), which in turn positions negative feed pawl guard (6) allowing rachet (5) to retract the negative carbon when the arc voltage is less than 78 volts. Ratchet (7) is engaged when the voltage is greater than 78 volts. Thus it keeps the negative carbon positioned so as to maintain a constant arc length. It functions on the principle that the arc voltage varies directly with the arc length.

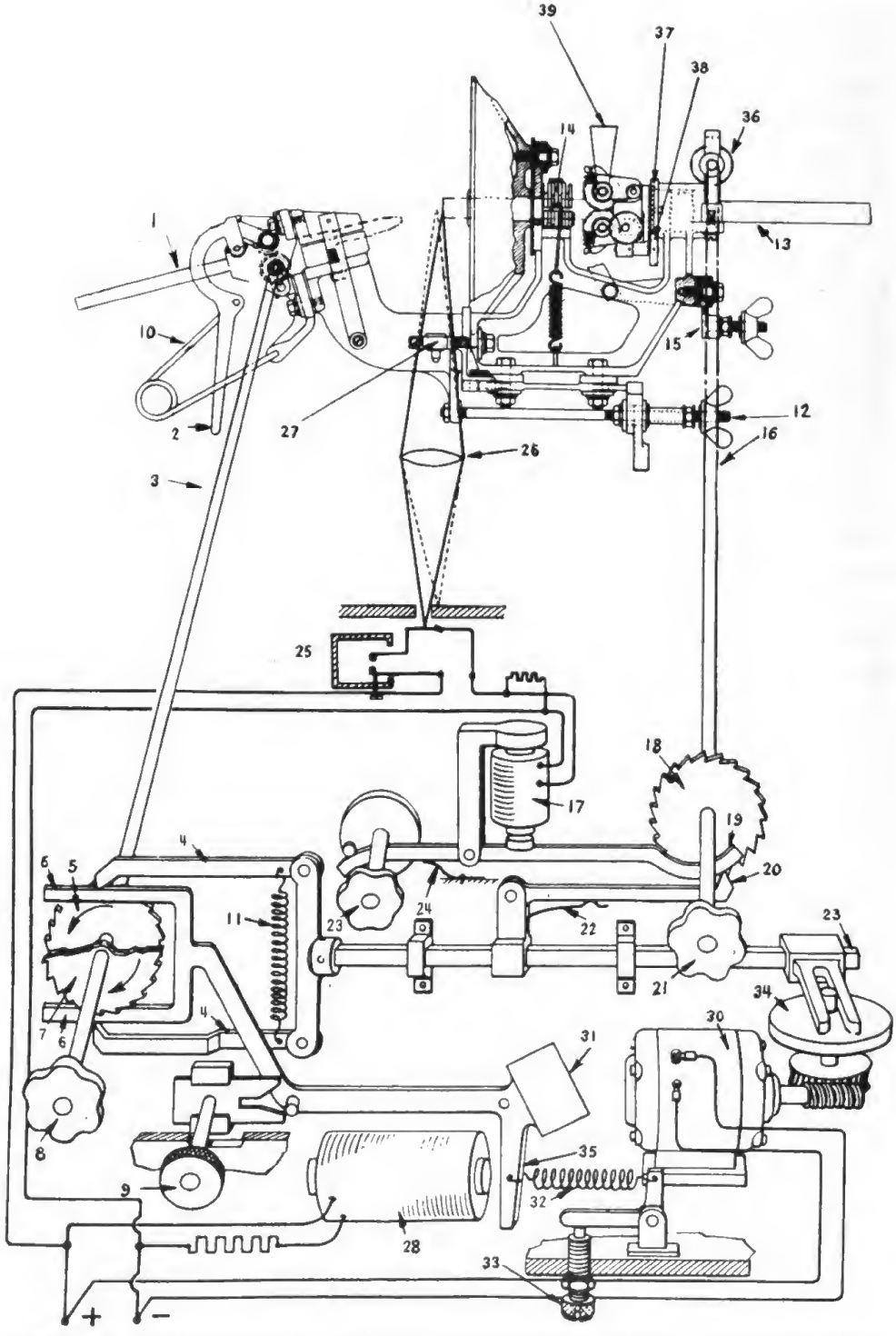


FIGURE 29.—Schematic diagram of the Sperry M1940 lamp and lamp control mechanism.

1. Negative carbon.
2. Negative release lever.
3. Negative control rod.
4. Negative feed pawls.
5. Negative feedback ratchet.
6. Pawl guards controlling negative feed.
7. Negative feed forward ratchet.
8. Negative hand feed knob.
9. Negative feed centralizer knob—for hand feed.
10. Negative carbon release spring.
11. Negative feed pawl spring.
12. Negative terminal.
13. Positive carbon.
14. Positive contact.
15. Positive terminal.
16. Positive control rod.
17. Positive feed control electromagnet.
18. Positive feed ratchet.
19. Positive feed control guard.
20. Positive feed pawl.
21. Positive hand feed knob.
22. Positive feed pawl spring.
23. Positive feed rate adjustment knob.
24. Positive feed electromagnet spring.
25. Thermostat.
26. Thermostat lens.
27. Lens positioning screw.
28. Arc length control coil.
29. Reciprocating feed member.
30. Feed motor.
31. Counterbalance.
32. Adjustment spring.
33. Arc length adjustment screw.
34. Eccentric disk.
35. Balanced armature.
36. Gear.
37. Fixed gear.
38. Planetary gear.
39. Recarboning wrench (shown in position for recarboning only).

25. Operation of Sperry searchlights.—*Q.* In what two ways can the arc be struck? *A.* Automatically or manually.

Q. Describe each briefly. *A.*

(1) *Automatically.*—With the lamp control mechanism set for automatic operation, close the arc switch. The negative carbon will automatically strike the arc and maintain the proper arc length.

(2) *Manually.*—First, centralize the negative feed pawls by moving the negative feed centralizer lever (or knob) to the hand position. This will allow feeding of the negative carbon by hand. Second, move the negative carbon forward by means of the negative hand-feed knob. Third, after striking the arc, retract the negative carbon until the voltmeter reads approximately 78 volts.

Q. In the 1941 Sperry light what automatic provision is made to strike the arc quickly? *A.* The arc switch incorporates an additional switch known as a thermal-operated circuit breaker. This circuit breaker is designed to close 5 to 7 seconds after the main arc switch is opened. The closing of the circuit breaker causes the negative carbon to feed forward rapidly, attempting to strike a new arc. When the carbons touch, a short-circuit condition is caused which opens the circuit breaker and prevents the restriking of the arc. Thus the negative carbon is left in contact with the positive carbon and is in position for a quick strike of the arc.

Q. What are the dimensions and burning time for the carbons? *A.*

Carbon	*Size*	*Burning time (approximately)*
Positive	22 inches by 0.633 inch outside diameter	1½ hours
Negative	12 inches by 0.434 inch outside diameter	1½ hours

Q. When recarboning, should you use new carbons? *A*. Yes, always use a pair of full-length carbons.

Q. Before entering the drum what should you do? *A*. Make sure that the arc switch is open. In the Sperry M1941 light be especially sure that the recarboning safety switch has been thrown to the recarboning position.

Q. How would you insert a new positive carbon? *A*. Spread the feed roller brackets apart by means of the recarboning key. Insert the new carbon until it projects $^{13}/_{16}$ of an inch beyond the positive nose cap. Turn the recarboning key slowly until it permits the positive rollers to grip the carbons.

Q. Explain the recarboning of the negative head. *A*. Push the lower end of the negative carbon release lever toward the positive head so that the negative carbon may be readily inserted through the rear of the head. Move carbon in until it projects approximately one inch beyond the negative nose cap. Return the release lever slowly to its normal position. Never allow the lever to snap back as this may break the negative carbon.

Q. How could you operate the searchlight if the thermostat or the positive control electromagnet failed? *A*.

(1) *Sperry M1941*.—Turn the positive feed rate adjustment screw approximately one and one-fourth turns counterclockwise toward "semi." The position of the positive carbon should be carefully watched to keep it at the focal center. The positive carbon can be fed forward by depressing the positive hand feed lever whenever the positive carbon is behind the focal point.

(2) *Sperry M1940, M1939, M1937, M1934, M–VI*.—Turn the positive feed rate adjusting knob (23) counterclockwise toward "semi." The positive carbon will feed forward at a rate so as to approximately position the positive crater at the focal point. Because of the absence of automatic control, the position of the carbon should be watched carefully through the ground glass view finder to prevent over or under feeding.

Q. How could you operate the searchlight if the arc length control coil should fail? *A*. Set the negative feed centralizer lever or knob to hand position and turn the negative hand feed knob so as to maintain the required searchlight voltage of 78 volts.

Q. How is the interior of the lamp drum kept cool during operation? *A*. There is a small motor-driven fan on top of the searchlight drum which draws air from openings at the bottom and side of the searchlight and exhausts the hot gases out through the top.

26. Maintenance of Sperry searchlights.—*Q.* Should coarse sandpaper ever be used on the searchlight? *A.* No. Unless otherwise specified, use No. 00 sandpaper whenever an abrasive is required for cleaning this equipment.

Q. How often should the negative head contact surfaces be cleaned? *A.* After every *third* change of carbons. Wrap a piece of No. 00 sandpaper around a negative carbon stub and work it back and forth in the negative head. Clean all abrasive materials from the surfaces.

Q. How often should the positive carbon contact surfaces be cleaned? *A.* After every *tenth* change of carbons. The brushes must be removed. Then with No. 00 sandpaper around a positive carbon stub move it back and forth between the two brushes. Wipe off all dust.

Q. Should the carbon contact surfaces ever be reamed out? *A.* Only in extreme circumstances.

Q. What lubrication is necessary after every 10 hours of operation? *A.* If the lamp has been lubricated with a graphite and oil mixture, place a few drops of a mixture of machine oil and kerosene on the bearings and gears of the lamp mechanism. If the lubricant Aquadag has been used this is not necessary.

Q. What cleaning and lubrication of the lamp mechanism are necessary after every 50 hours of operation? *A.* If Aquadag has been used, no cleaning is necessary. In any case, at periods of 2 months, the entire lamp mechanism must be washed thoroughly with gasoline with the exception of the positive drive pinion bearing, the main positive feed bearing, and the roller bearing in the semifixed gear (all ball and roller bearings). Aquadag may be used as a lubricant. When Aquadag is used, apply with a spray gun when the lamp head is *hot.*

Q. What else should be lubricated every 50 hours of operation (or every 2 months)? *A.*

(1) The ventilating motor bearings (accessible after removing the ventilating motor fan housing) should have a small amount of medium motor oil at the time the motor is inspected (once every 3 months).

(2) Feed motor bearings should be oiled and the feed motor worm gear should be greased with a high temperature grease every 3 months.

(3) The feed mechanism ball bearings must be oiled with light machine oil from inside the drum.

(4) All alemite fittings must be greased at least once a month.

(5) Azimuth and elevation control (training) motors must be oiled once a month with medium oil.

Q. How should the mirror be cleaned? *A.* It should be cleaned only with the solution supplied for that purpose, and cotton pads should be used for applying and removing the cleaning agent. Do not allow the solution to accumulate on the mirror supporting clips. Before using this solution the mirror should be dusted off lightly with a soft camel's-hair brush. Never clean the mirror with a rotary motion; always pass the pad over the mirror surface from the center toward the edge. The cleaning solution contains ammonia, so be sure to have sufficient ventilation inside the drum when using it.

Q. How is the thermostat cleaned? *A.*

(1) Remove the thermostat from the searchlight drum and place it on a suitable flat surface, preferably a workbench.

(2) Remove the four cover screws and cover.

(3) Unscrew the contact assembly holding screws and remove the contact assembly.

(4) Clean the points with crocus paper, being careful not to bend the contact arms and to avoid excessive rubbing with the abrasive.

(5) When finished cleaning, draw a piece of white paper between the contacts to wipe off any abrasive that may be left on the points.

(6) Reassemble the thermostat and replace it in its position in the drum.

Q. How are the supply and control slip rings cleaned? *A.* Access to these rings may be had through the handhole plate in top of the base of the searchlight. The rings should be cleaned with alcohol whenever necessary—at least every 3 months. Use No. 00 sandpaper, if necessary, to clean any burned spots.

Q. How should the carbons be protected? *A.* Keep the carbons dry and protect them against jarring that might crack the carbons or their cores.

Q. How are the motor brushes cleaned? *A.* After every 50 hours of operation remove the brushes and wash them in gasoline. Wash each brush and replace in its original position. Make sure that the brushes slide freely in their holders.

Q. How and when should the time delay mechanism of the M1941 searchlight be lubricated? *A.* It should be lubricated with light machine oil at intervals as determined by inspection.

27. Operation of General Electric M1940 searchlights.—*Q.* Describe briefly the operation of the General Electric lamp mechanism. *A.*

(1) *Positive feed.*—See figure 30. The lamp motor, through a set of gearing and shafts, drives a helical gear on the positive head, which transmits a constant rotary motion to the yoke and positive carbon. When the detent is not engaged with the detent gear, the entire assembly, including the spur gear, rotates with the yoke. When the detent is engaged with the detent gear, the spur gear attached to the detent wheel is kept from rotating, causing the outside gear to rotate around the attached spur gear, thereby causing the feed rollers, through a worm drive, to feed the positive carbon forward.

(2) *Negative feed.*—The lamp motor, through a set of bevel gears, rotates the negative drive shaft. Mounted on and keyed to this shaft is a sliding armature friction driver which rotates with, but is free to slide along, the shaft. On each end of the sliding armature friction driver is a friction collar, either of which by proper positioning of the sliding armature can drive a friction-driven disk. This friction-driven disk is connected by shafting and gearing to the negative feed pawls. Positioning of the sliding armature friction driver is controlled by two stationary electromagnets, each of which is built around one of the friction collars. One of these electromagnets is termed the feed coil and the other the retract coil. When the feed coil is energized, the sliding armature friction driver is positioned so that the friction-driven disk is rotated in the proper direction to cause the feed rollers to feed the negative carbon forward. When the retract coil is energized, the direction of rotation of the friction-driven disk is reversed and the negative carbon is retracted.

Q. What actuates the detent? *A.* The positive feed magnet, when energized, causes an armature to turn; this turns a shaft which causes the detent to engage the detent gear. This armature may also be actuated manually by pushing the manual positive feed.

Q. How is the positive feed magnet energized? *A.* It may be energized from two sources:

(1) By the thermostat, whenever the positive carbon burns back from the focal point of the mirror.

(2) By the closing of the positive feed contacts which are actuated by rotation of a cam. This provides an intermittent feed to the positive carbon which is somewhat less than the rate of burning of the positive carbon.

Q. Can the positive feed rate be adjusted? *A.* Yes, by turning the manual positive feed adjustment knob. This knob provides for a rate of feed from a minimum of 6.5 inches per hour to a maximum of 12 inches per hour.

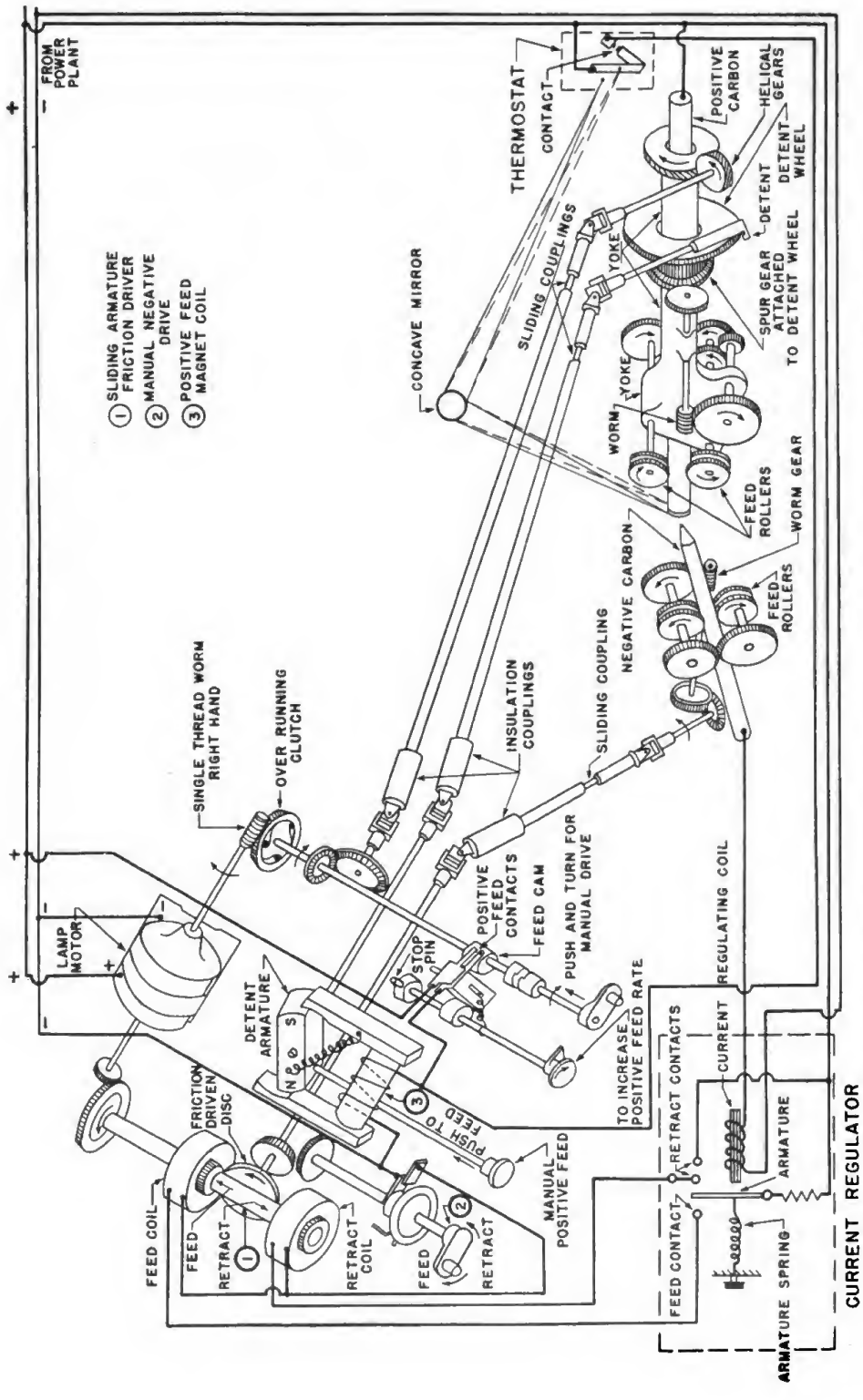


FIGURE 30.—Schematic diagram of General Electric lamp control mechanism and lamp mechanism.

Q. Can the positive carbon be fed forward manually? *A.* Yes, by pushing in and turning the manual drive crank clockwise, at the same time pushing in the manual positive feed button.

Q. What should be done if the thermostat fails? *A.* By observing the positive arc crater on the arc image screen, the crater can be moved to the focal point by simply pushing in the manual positive feed button and holding it until the positive crater returns to the focal point.

Q. How is the negative carbon kept at its proper position? *A.* By means of the current regulator, which is electrically connected to the feed coil and retract coil.

Q. How does the current regulator operate? *A.* The current regulator operates on a current principle. When the arc length is normal the current through the regulator is 150 amperes. This condition will cause the movable contact to be centered and neither the feed coil nor retract coil will be energized. When the current increases or decreases from the normal value of 150 amperes, as a result of a change in the arc length, the movable contact on the regulator will move to close either the feed coil circuit or the retract coil circuit. This in turn will cause the carbon to resume its normal position.

Q. Can the negative carbon be fed or retracted manually? *A.* Yes, by pushing in the manual negative drive and turning the crank in the desired direction.

Q. How is the lamp kept cool? *A.* There is a small motor-driven fan located on top of the searchlight which draws air from openings in the drum and through the lamp support column.

Q. How can the arc be struck? *A.* Either automatically or manually.

(1) *Automatically.*—Close the main switch. The current regulator will cause the negative carbon to feed forward rapidly until the negative carbon touches the positive carbon. The rush of current will cause the retract coil to operate and retract the carbon quickly to its normal position where it will draw 150 amperes.

(2) *Manually.*—Push in the manual negative drive and turn the crank clockwise to feed the negative carbon forward until it strikes the positive carbon. Then quickly turn the crank counterclockwise and retract the carbon until the normal current of 150 amperes is indicated on the ammeter. When the manual negative drive crank is pushed in, an electric interlock opens the circuits of the magnetic clutch coils, thus preventing the automatic negative drive mechanism from functioning.

Q. When using the distant electric control, what actually positions or trains the searchlight? *A*. Two small direct current motors, one for training in azimuth and the other for training in elevation.

Q. What should you check before entering the drum? *A*. Make sure the arc switch is open.

Q. How is the lamp recarboned? *A*.

(1) *Positive carbon.*—(*a*) Release feed rollers by means of the feed roller clamp lever.

(*b*) Insert new carbon through the hole in the positive head.

(*c*) Set tip of the carbon so that it extends ¾ to ⅞ of an inch beyond the obturator nose.

(*d*) Secure feed roller clamp lever so that the positive rollers grip the carbon.

(2) *Negative carbon.*—(*a*) Push release lever (negative carbon drive roller handle) in the direction of the positive head.

(*b*) Insert negative carbon and push it forward until the point is about ¼ inch from the positive carbon tip.

(*c*) Secure feed roller levers.

Q. How should the carbons be stored? *A*. They should be kept dry, in their cases, and protected against jarring or breaking.

Q. With respect to the positive carbon, when the arc is burning what should the operator especially observe? *A*. He should be particularly careful that the tip of the positive carbon does not burn beyond the line marked "Danger," otherwise serious damage may result from burning of the obturator on the positive head. Furthermore, the operator must observe the beam in order to judge the satisfactory operation of the arc.

28. Maintenance of General Electric M1940 searchlights.—*Q*. Name the parts which should be cleaned daily. *A*.

(1) Positive and negative contacts. Use the cleaning stone on the alinement gage.

(2) Thermostat mirror. Use a clean, dry cloth or chamois skin.

(3) Obturator. Remove all dust, and ream if necessary with the reamer included in the tool kit.

Q. How is the thermostat cleaned? *A*. Remove the thermostat and inspect the contacts for pitting or burning. If necessary, clean the surface of the contacts by passing a fine clean file between the contacts. Replace the thermostat.

Q. How should the collector rings be serviced? *A*. The collector rings are accessible through a handhole in the searchlight turntable. The collector rings should be cleaned with a clean cloth soaked in alcohol. If the rings are discolored they may be polished by using

a clean chamois skin. If the rings are pitted or burned, use a clean thin file for smoothing the surface. Great care must be taken not to remove the thin silver coating on these rings.

Q. How is the mirror cleaned? *A.* The mirror surface is of precious metal, and great care should be taken in cleaning it. The mirror should be cleaned with the solution supplied for that purpose. Use only dry cotton pads for applying and for wiping off the solution. Before using the solution, remove any dust with a soft camel's-hair brush. Never clean the mirror with a rotating movement; always pass the pad over the mirror surface from the center toward the edge. This cleaning solution contains ammonia, so the drum should be well ventilated while the solution is being used.

Q. In lubricating, what should you watch for? *A.* Be careful not to overlubricate. All excess lubricant should be carefully wiped off. Make sure that oil or grease does not get on the motor brushes, brushholders, commutators, coils, or slip rings.

Q. How should the lamp bearings and lamp head gears be lubricated? *A.* All lamp bearings and lamp head gears subject to high temperatures should be lubricated with Aquadag, a material consisting of graphite in suspension in water. If Aquadag is not available, then use flake graphite diluted in kerosene. When Aquadag is used it should be sprayed on; if a spray is not available then apply sparingly with a brush.

Q. What other parts require lubrication? *A.*

(1) The worm and gear of the lamp motor positive drive should be lubricated frequently but not excessively.

(2) The bearings of the lamp control mechanism should be lubricated with a few drops of light machine oil.

(3) The bearings of the dynamotor are filled with grease at the factory; they should be lubricated from time to time through tapped holes in the bearings.

Q. Where can I find information on adjustments and trouble shooting? *A.* In the Operator's Manual furnished with each searchlight.

Section III

CONTROL STATIONS

29. General.—*Q.* How can the searchlight be controlled or trained? *A.* Two means are provided:

(1) The extended hand controller.

(2) The distant electric control.

Q. What does the control station accomplish? *A.*

(1) Provides remote control of the searchlight.

(2) Synchronizes the searchlight with sound locator data.

(3) Positions the binocular and open sight assembly.

NOTE—The Sperry M–VI does not have a binocular mount.

30. Sperry M1941, M1940, M1939, and M1937 control stations.—*Q.* Of what does the control station consist? *A.* It consists of a tripod, control unit, and binocular mount.

Q. How is the searchlight synchronized with the sound locator data? *A.* Self-synchronous transmitters on the sound locator transmit electrically the angular movements of the sound locator to self-synchronous receivers which are mounted and geared to the searchlight. The electrical output of the receivers goes to a phase detecting circuit, thence to direct current, double throw, zero reading voltmeters. When the indicator on the zero reading voltmeter is at the zero position, the searchlight is pointed or synchronized with the sound locator data. There are a total of four zero reading voltmeters, two for azimuth and two for elevation. One set (one azimuth and one elevation) of zero readers is mounted on the searchlight drum, and the other set is mounted on the control station.

Q. How many men are required to operate the control station? *A.* Three: an azimuth zero reader operator, an elevation zero reader operator, and an observer.

Q. What are the duties of each man? *A.*

(1) The zero reader operators turn their respective handwheels to keep the zero pointers on the center or zero position of the azimuth and elevation zero reader indicators. If the target is not flicked when the searchlight goes into action, the zero reader operators cause the searchlight (except in the M1937 control station) to search in the vicinity of the sound locator data by operating their handwheels so as to cause the pointers of the zero reader meters to move slowly, alternately to the right and left of the zero position. In the M1937 control station an automatic means is provided for searching; pushing down the search control knob operates an automatic search in elevation; turning the search control knob offsets the potentiometer which controls the pointer of the azimuth zero reader; thus the observer controls an automatic search in elevation, and a search in azimuth by offsetting the pointer of the azimuth zero reader.

(2) When the target is flicked the zero reader operators relinquish control of their respective handwheels and the observer then takes over the control and follows the target by means of the observer's handwheels.

Q. What is actuated when the azimuth zero reader's handwheel, or observer's azimuth handwheel, is turned? *A*. The control unit is turned in azimuth and the azimuth distant electric control transmitter is driven in azimuth. This causes the searchlight also to be moved in azimuth.

Q. What is actuated when the elevation zero reader's handwheel, or observer's elevation handwheel, is turned? *A*. The binocular mount is moved in elevation and the elevation distant electric control transmitter is driven in elevation. This causes the searchlight to be elevated or depressed.

Q. Is there a means of signaling at the control station? *A*. Yes. There is a push button on the control station that operates a buzzer on the searchlight. On the M1941 control station there is a buzzer which is operated by a push button at the sound locator.

Q. What is the color of the control cable plugs and receptacles? *A*. Red.

Q. What is the minimum distance that the control station should be placed from the searchlight? *A*. 50 feet.

Q. What type of distant electric control is used on Sperry searchlights, with the exception of the M–VI? *A*. A direct current step-by-step system, which operates on the same voltage as does the arc.

31. Sperry M1934 control station.—*Q*. Of what does the control station consist? *A*. It consists of a tripod and control unit, including binoculars.

Q. How is the searchlight made to follow the sound locator data? *A*. Self-synchronous transmitters on the sound locator transmit, electrically, the angular movements of the sound locator to self-synchronous receivers, which are mounted in the control station and position an inner dial of a set of concentric dials. The outer dials are geared to the control unit and indicate the azimuth and elevation of the control unit and searchlight when correctly oriented and synchronized.

Q. How is searching accomplished? *A*. The searching is accomplished by a searching handwheel which superimposes an additional motion to the elevation and azimuth transmitters.

Q. How many men are required to operate the control station? *A*. Three: observer, azimuth follow-the-pointer operator, and elevation follow-the-pointer operator.

Q. What are the duties of each man? *A.* The follow-the-pointer men at the control station operate their handwheels so as to keep the searchlight dials continuously matched with the sound locator dials. If the target is not flicked, the observer should start searching by turning the searching handwheel continuously in a clockwise or counterclockwise direction. When the target is flicked, the follow-the-pointer men should relinquish control of their respective handwheels to the observer, who from then on follows the target by means of the observer's handwheels.

Q. What type of distant electric control is used on the M1934 Sperry searchlight? *A.* A direct current step-by-step system, which operates on the same voltage as does the arc.

32. Sperry M–VI control station.—*Q.* Of what does the control station consist? *A.* It consists of a tripod, controller, and comparator.

Q. How is the searchlight made to follow the sound locator data? *A.* Self-synchronous transmitters on the sound locator transmit, electrically, the angular movements of the sound locator to self-synchronous receivers, which are mounted in the comparator and positions an outer dial of a set of concentric dials. The inner dial is positioned by a self-synchronous receiver which is electrically connected to a self-synchronous transmitter on the searchlight. Operating the controller handwheels causes the searchlight to be trained in elevation and azimuth, and when the pointers on these two concentric dials at the comparator are matched, the searchlight is pointing in the proper direction, if the searchlight unit has been correctly oriented and synchronized.

Q. How many men are required to operate the control station? *A.* Three: observer, azimuth follow-the-pointer operator, and elevation follow-the-pointer operator.

Q. What are the duties of each man? *A.* The follow-the-pointer men at the control station operate their handwheels so as to keep the searchlight dials continuously matched with the sound locator dials. If the target is not flicked the follow-the-pointer men cause the searchlight to search around the sound locator data by manipulating their respective handwheels so as to cause the searchlight pointer to move slowly back and forth within 5° of the sound locator pointer.

Q. What type of D. E. C. is used by the M–VI searchlight? *A.* A brush shifting type. The handwheel at the comparator positions a d-c step-by-step transmitter which in turn positions a d-c step motor

at the searchlight, causing the brushes of the training motor to be shifted, imparting a torque to the training motor.

33. Maintenance of Sperry control stations.—*Q*. Should the azimuth gear and pinion be lubricated? *A*. No. They should be cleaned once a month with gasoline and never lubricated, as lubricating will cause dust and dirt to gather on the gear teeth.

Q. How should the electrical contact rings and brushes be cleaned? *A*.

(1) Clean with alcohol when needed. Use No. 00 sandpaper if necessary to clean burned spots.

(2) The slip rings and brush assemblies in the tripod should be cleaned every 6 months.

(3) The D. E. C. transmitter rings and segments should be cleaned every 3 months.

(4) All electrical contacts should be clean and bright. Wipe off all contacts after using an abrasive. Do not permit oil or grease on the insulation.

Q. How should the control station be lubricated? *A*. Due to the fact that most of the control unit mechanism bearings are grease-sealed at the factory, little attention to lubrication is required. However, when the control unit cover is removed for cleaning, the gear teeth and bearings should be inspected and a few drops of machine oil applied as necessary.

34. General Electric M1940 control stations.—*Q*. Of what does the control station consist? *A*. It consists of a tripod, control unit, and binocular mount.

Q. What type of D. E. C. is used by the General Electric M1940 searchlight? *A*. A self-synchronous control system which controls the operation of the d-c training motors.

Q. How are data transmitted from the sound locator? *A*. From self-synchronous transmitters on the sound locator to receivers on the searchlight, then to zero reading voltmeters on the searchlight and control station.

Q. How are the movements of the control station transmitted to train the searchlight? *A*. The rotation of the handwheels at the control station positions a self-synchronous transmitter, which in turn causes a rotor on the searchlight self-synchronous receiver to follow the rotation of the transmitter rotor. The rotor on the searchlight receiver positions a heart-shaped cam which controls a contact operating plate in a resistance bridge. Movement of the contact operating plate changes the bridge resistance in such a way as to control the operation of a direct current driving motor on the searchlight. When

the searchlight has been rotated the required amount, the heart-shaped cam is set back to its neutral position in the following manner: A system of gears from the searchlight turns the stator housing of the self-synchronous receiver in the opposite direction to that of the receiver rotor. This movement is reflected in a corresponding rotor movement which returns the heart-shaped cam and contact operating plate to the neutral position.

Q. How many revolutions of the distant electric control transmitters and receivers correspond to one revolution of the searchlight? *A.* The D. E. C. transmitters and receivers make 36 revolutions for each revolution of the searchlight. Therefore, the control station and the searchlight will be auto-synchronous only in a 10° arc.

Q. How many men are required to operate the control station? *A.* Three: an azimuth zero reader operator, an elevation zero reader operator, and an observer.

Q. What are the duties of each man? *A.* The zero reader operators turn their respective handwheels to keep the zero pointers on the center or zero position of the azimuth and elevation zero reader indicators. If the target is not flicked when the searchlight goes into action, the zero reader operators cause the searchlight to search in the vicinity of the sound locator data by operating their handwheels so as to cause the pointers of the zero reader meters to move slowly, alternately to the right and left of the zero position. When the target is flicked the zero reader operators relinquish control of their respective handwheels and the observer then takes over the control and follows the target by means of the observer's handwheels.

Q. What is actuated when the azimuth zero reader's handwheel or observer's azimuth handwheel is turned? *A.* The control unit is turned in azimuth and the azimuth distant electric control transmitter is driven in azimuth. This causes the searchlight also to be moved in azimuth.

Q. What is actuated when the elevation zero reader's handwheel or observer's elevation handwheel is turned? *A.* The binocular mount is moved in elevation and the elevation distant electric control transmitter is driven in elevation. This causes the searchlight to be elevated or depressed.

Q. Is there a means of signaling at the control station? *A.* Yes. There is a push button on the control station which operates a buzzer on the searchlight. On the M1941 control station there is a buzzer which is operated by a push button at the sound locator.

Q. What is the color of the control cable plugs and receptacles? *A.* Red.

Q. What is the minimum distance that the control station should be placed from the searchlight? *A.* 50 feet.

35. Maintenance of General Electric M1940 control stations.—*Q.* How should the control station be cleaned? *A.*

(1) The azimuth ring gear and pinion should be cleaned monthly by means of a brush dipped in gasoline. Do not lubricate this gear of pinion, since it would tend to accumulate dirt and dust.

(2) The brush-holder and rings should be cleaned with alcohol every 6 months. They should be kept clean by wiping from time to time.

(3) All electrical contacts should be clean and polished. Never allow oil or grease to accumulate on the insulation.

Q. How should the control station be lubricated? *A.* Most of the bearings are sealed in oil at the factory. However, when the cover is removed for cleaning, inspect the teeth of the gears and bearings and, if necessary, apply a small quantity of grease to the gears and a few drops of light machine oil to the bearings.

Section IV

SOUND LOCATOR APPARATUS

36. General.—*Q.* What faculty of an individual enables one to determine the direction from which a sound is coming? *A.* Binaural sense. It is a faculty of the auditory system.

Q. Are the horns pointed at the true source of the sound? *A.* No. The horns point at the apparent source of the sound due to the fact that sound travels in air at a speed of 1,100 feet per second, and consequently takes an appreciable time to arrive at the sound locator. During this sound lag time the airplane is traveling. The direction to the apparent source of sound is then corrected by the sound lag corrections (plus wind and parallax) in order to point the searchlight at the true source of sound.

37. Operation of the M1 series sound locators.—*Q.* How are the horns of an M1 series locator put in their operating position? *A.* Remove horns from the traveling position supports by releasing the horn locking frame pins. Then clamp horns into place on the horn support by means of the double hooks and hand clamp screws. Be sure the numbers on the horns and supports correspond.

Q. How is the locator chassis leveled? *A*.

(1) Unlock turntable by loosening the three locking screws.

(2) Lower four leveling jacks, then by means of these jacks raise the trailer chassis until the four wheels are free to turn.

(3) Move turntable so the level bubbles point over diagonal wheels. Adjust the jacks until the two level bubbles located on the turntable show that the sound locator is level. After leveling, check by turning the locator through 180°. (See fig. 19.)

Q. How is the sound locator oriented in azimuth? *A*. With the aid of the open sights on the lower elevation horn, orient the sound locators with respect to the searchlight. Then set the azimuth on the acoustic corrector with all correction scales set to zero, to zero degrees (on M1A1 to M1A4, incl.), or to zero mils (on M1A5 to M1A8, incl.).

Q. How is the sound locator oriented in elevation? *A*. Set the sound locator horns to zero elevation. Then set the acoustic corrector to zero degrees (or zero mils).

Q. How is the sound locator operated? *A*. Each listener seats himself at his control handwheel, adjusts his helmet, and is ready for action. The horns are then placed in the general direction from which the sound is expected (from information given by outpost listeners), or a systematic search is made for possible attacks by enemy airplanes. As soon as a sound is picked up, both operators center on the sound so that it appears to come from directly in front or directly in the rear of the listener's head (the direction is sensed as front or rear by different listeners), and when this is done the sound locator will be pointed at the apparent source of sound.

Q. How is the M1 or M1A1 acoustic corrector operated? *A*. The chief of section announces the altitude in feet, which is set in by the elevation acoustic corrector operator. As the listeners track the target, the azimuth acoustic corrector operator reads the time on the sound lag cylinder which is graduated in seconds; if it is 4.2 seconds, he calls "four-point-two," at which time both corrector operators push their prediction knobs in. At the end of 4.2 seconds (measured by a stop watch) the chief of section gives the command TAKE, at which time the corrector operators release their prediction knobs. The angles indicated on the prediction scales by the prediction pointers are the sound lag angles and are matched by causing the follow up pointers to agree with the prediction operating pointers. This corrects the apparent source data to the true source and is sent by the data transmitters to the searchlight. (Arbitrary corrections must

be set in on the arbitrary correction scales to correct for wind and parallax.) (See fig. 20.)

Q. How is the M2 acoustic corrector operated? *A.* The chief of section directs the duties of the corrector operator. This acoustic corrector uses a motor (a switch on the acoustic corrector must be turned to the "on" position) which operates automatically the mechanisms which measure azimuth and vertical angular travel during the sound lag time. Altitude in feet is set in by the operator on the altitude scale. As the sound locator tracks the target, the operator alternately matches the pointers of the lateral and vertical rate dials by rotating the corresponding handwheels. The matching of pointers must be done within the 4-second period when the inner pointers are at rest. (See fig. 21.)

38. Maintenance of M1 series sound locators.—*Q.* If the locator is to be left assembled after use, should the horns be elevated or depressed? *A.* The horns should be depressed as far as possible in order to prevent rain from entering them.

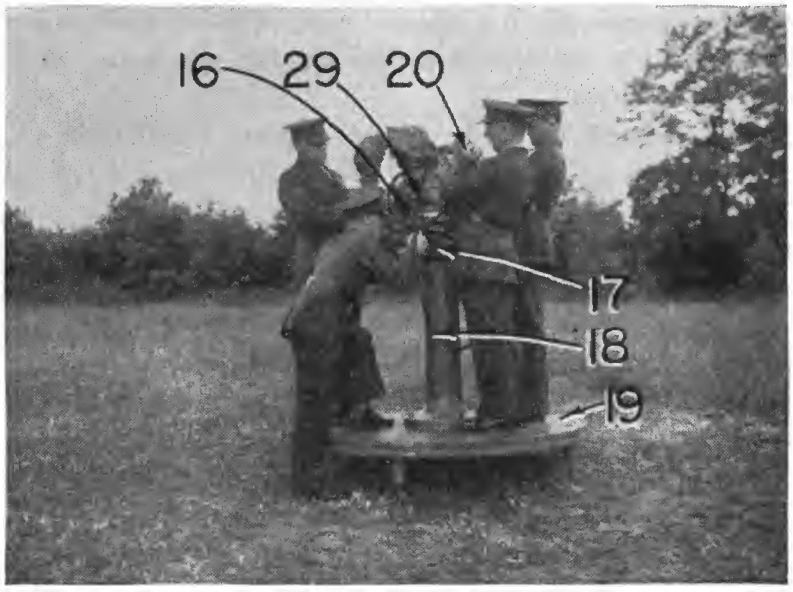
Q. How often should the horn mount be lubricated? *A.* Each day before operating the locator. Alemite fittings are provided. Use medium lubricating oil (SAE No. 30) for summer operation and light lubricating oil (SAE No. 20) for winter operation. An oil gun is provided for this purpose. These alemite fittings are located as follows:

Azimuth handwheel shaft and gear housing	4
Elevation handwheel shaft and gear housing	4
Traversing worm housing	6
Elevation shaft housing (horizontal)	9
Elevation worm segment housing	5
Horn journal (left)	1
Horn journal (right)	2
Turntable	1
Gear housings (below platform)	7

Q. How often should the trailer be lubricated? *A.* Every 500 miles. Alemite fittings are provided. Use medium lubricating grease (SAE No. 160) for summer operation and light lubricating grease (SAE No. 90) for winter operation. A grease gun is provided for this purpose.

Q. How often should the acoustic corrector be lubricated? *A.* The acoustic correctors require no maintenance in the field. Every 6 months the covering plates should be removed and the corrector lubricated. On the cam of the M2 corrector use petrolatum (U. S. Army Spec. No. 2–67). For the gearing and shafting use grade 2 clock oil (U. S. Army Spec. No. 2–47A).

39. Operation of M2 sound locator.—*Q*. Describe the assembling of the M2 sound locator for field operation. *A*. Place the platform at the position indicated by the chief of section, and adjust until the platform is approximately level. Place the column on the platform and bolt it in place. Place the corrector assembly on the column, first dropping the cable receptacle through the inside of the column. Bolt the corrector assembly to the column and fasten the cable receptacle to its bracket under the platform. Remove the transportation bracket. Elevate the elevation mechanism to 90° and clamp tightly by means of



16. Corrector assembly.
17. Cable plug (female).
18. Column.
19. Platform.
20. Transportation bracket.
29. Azimuth handwheel clamp knob.

FIGURE 31.—Placing corrector assembly on column.

the elevation clamp. Bolt the single horn assembly in place, then the two-horn assembly. The horns are handled more easily if the canvas covers are removed after horns are assembled. Mount the pantograph on the corrector, screwing it on by means of the pantograph screw knob. Level the sound locator exactly, using the wrench provided to adjust the jacks. Check the level bubble through 180° traverse of the sound locator to insure correct leveling. Connect the blue cable plug to the blue receptacle.

Q. How is the M2 sound locator oriented? *A*.

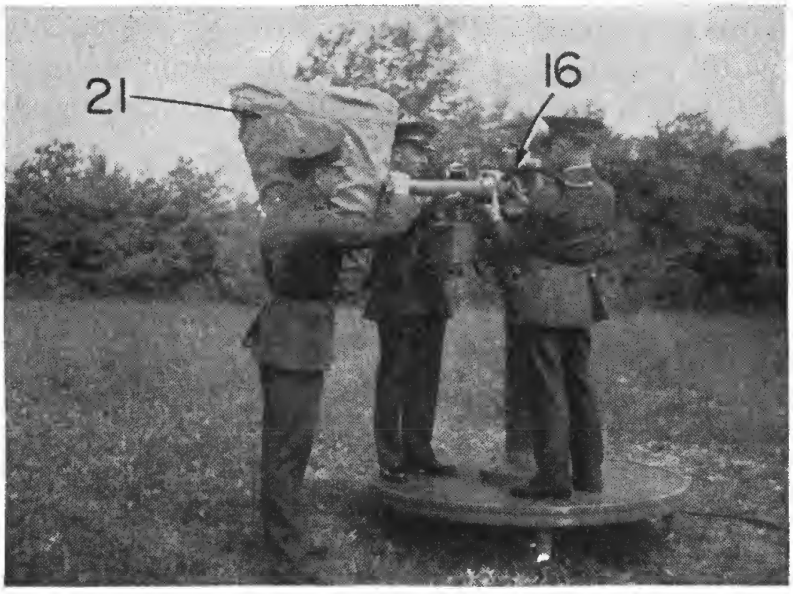
(1) *Azimuth.*—(*a*) Set target speed to zero.

(*b*) Set parallax offset scale to zero.

(*c*) Loosen azimuth clamp knob and point sound locator at the orienting point (searchlight or distant point), using the corrector sight

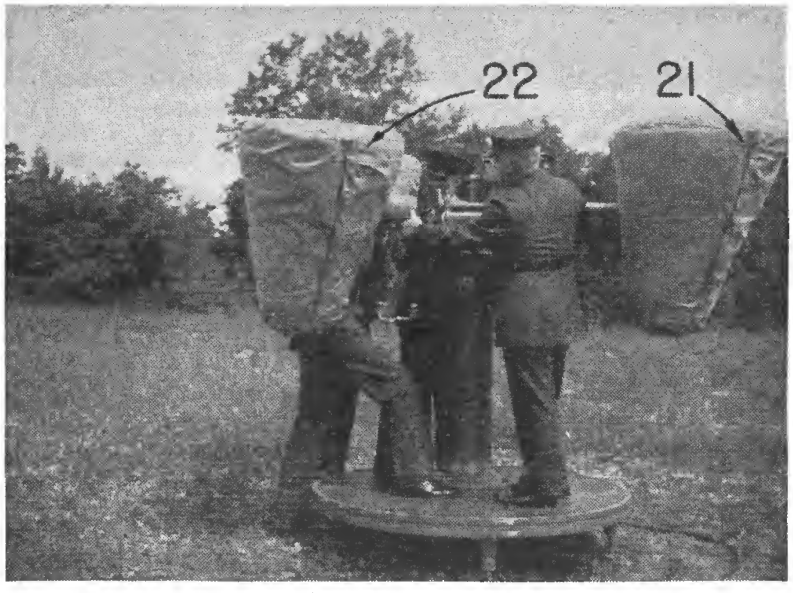
and getting the image of the pantograph pointer and the orienting point to coincide on the cross lines of the mirror. Be careful not to disturb the corrector handle until completion of orienting and synchronizing in azimuth.

(*d*) Tighten azimuth clamp to hold sound locator in position.



16. Corrector assembly. 21. Azimuth horn.

FIGURE 32.—Attaching azimuth horn to corrector assembly.



21. Azimuth horn. 22. Common (azimuth elevation) horn.

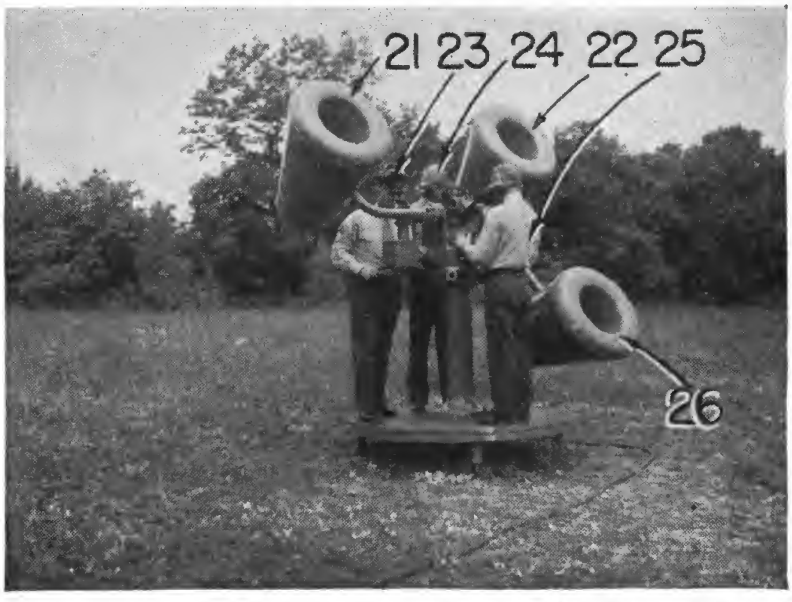
FIGURE 33.—Attaching elevation and common horn unit to corrector assembly.

(*e*) Set sound locator scale to zero by loosening the scale and turning it until zero on the scale is under the index pointer.

(*f*) Push down on declutching gear and rotate parallax cam so that the arrow points at the searchlight. Then remesh gearing.

(2) *Elevation.*—(*a*) Lock sound locator at zero elevation by means of the clamp lock.

(*b*) With zero speed and parallax settings, center pantograph pointer on the cross lines of the mirror. Be careful not to move the corrector handle thereafter until completion of orienting and synchronizing in elevation.



21. Azimuth horn.
22. Common (azimuth elevation) horn.
23. Corrector operator.
24. Elevation listener.
25. Azimuth listener.
26. Elevation horn.

FIGURE 34.—Sound locator M2 in operating position.

Caution: Even when the sound locator and the searchlight are at different levels, the foregoing elevation adjustment is not to be disturbed. This results in sighting on a vertical line through the orienting point instead of directly on the orienting point.

Q. How is the M2 sound locator operated? *A.* Set in the target's air speed and the parallax offset. This information is given by the chief of section. The corrector operator then keeps the pantograph pointer centered on the cross lines of the mirror, using the corrector handle to accomplish this. The listeners track the sound and should do this as smoothly and steadily as possible. Any sudden movement of the horns causes the pantograph pointer to move erratically. The

corrector operator must avoid any sudden change when he is centering the pantograph pointer because it will affect the data sent to the control station.

40. Maintenance of M2 sound locator.—*Q.* Who are authorized to make parts replacement on the M2 sound locator? *A.* Only qualified ordnance personnel are authorized to make parts replacement on the M2 sound locator.

Q. How often should the metal mirror be cleaned? *A.* Not any oftener than is necessary. If the mirror becomes greasy it may be cleaned with soft cotton moistened with alcohol. If the mirror becomes exceptionally dirty or greasy, the surface may be cleaned with a mixture of 3 ounces of precipitated chalk and 8 ounces of a good grade of denatured alcohol.

Q. How often should the slip rings be inspected? *A.* Monthly. If dirty, clean with a soft cloth moistened with carbon tetrachloride. Use only a clean cloth.

Q. How is the rubber guard on the open sight cleaned? *A.* Remove it and wash in warm water, then dust it with french chalk to preserve it.

Q. Should water be allowed to get in the horns? *A.* No. Water, dirt, or other foreign matter should be kept out of the horns.

Q. What parts of the sound locator should be lubricated? *A.* The three red plugs on the sight assembly should be lubricated, using a light instrument oil. In addition to the chain drives inside, the locator should be greased with Andok C grease, or, if this is not available, use a good grade of vaseline. To get at the chains remove the cover plate on the corrector.

Chapter 5

USE AND CARE OF TELEPHONES

41. Sending, receiving, and recording messages.—*Q.* For the best results, where should the telephone transmitter be placed with respect to the mouth? *A.* Not more than 1 inch from the mouth but not touching it.

Q. How should words be pronounced over the telephone? *A.* Use a moderate tone of voice. Speak slowly and distinctly without slurring any words or syllables. Avoid using words which are difficult to pronounce or with meanings not generally known. When necessary to repeat, make the pronunciation more distinct but never shout or raise the pitch of the voice.

Q. How are numerals sent? *A.* Singly. Thus, 4,370 is sent "four, three, seven, zero." Zero is never pronounced "O." A numeral involving a decimal, like 246.34, is sent thus: "two, four, six, point, three, four." An exact hundred, such as 200, is sent: "two hundred"; 4,500, "four five hundred." Even thousands are sent in the same manner, for example, 4,000 is "four thousand."

Q. What is the procedure when the receiver repeats the message back to the sender? *A.* Listen carefully to the message. If any part of the message is incorrectly repeated, call "error" and repeat that portion of the message. When the message has been correctly repeated back to the sender, the sender should call "check."

Q. What is the procedure if the sender discovers that he has incorrectly sent part of a message? *A.* He immediately calls "error" and identifies the portion of the message in error. He then gives the correct message. With short messages it is best for the sender to repeat the entire message.

Q. How are numerals pronounced? *A.*

Numeral	*Pronounced*	*Principal sounds*
0	ZE-RO	Long O.
1	WUN	Strong W and N.
2	TOO	Strong T and long OO.
3	THUR-REE	Slightly rolling R and long EE.
4	FO-WER	Long O, strong W and final R.
5	FI-IV	I changing from long to short and long V.
6	SIKS	Strong S and KS.
7	SEV-VEN	Strong S and V, and well-sounded VEN.
8	ATE	Long A and strong T.
9	NI-YEN	Strong N, long I, and well-sounded YEN

Q. What is meant by the phonetic alphabet? *A.* Certain letters of the alphabet have similar sounds and are often confused in telephone conversations. To avoid this difficulty, the following pronunciation of letters over the telephone is prescribed:

Letter	Spoken as	Letter	Spoken as	Letter	Spoken as
A	Affirm	J	Jig	S	Sail
B	Baker	K	King	T	Tare
C	Cast	L	Love	U	Unit
D	Dog	M	Mike	V	Victor
E	Easy	N	Negat	W	William
F	Fox	O	Option	X	X-ray
G	George	P	Prep	Y	Yoke
H	Hypo	Q	Queen	Z	Zed
I	Inter	R	Roger		

The words of the phonetic alphabet are used in place of the letters they represent just as in spelling a word. Expressions such as "A as in Affirm" or "A for Affirm" are not used. For example, in transmitting the words "Barts Church" the word "Barts" is apt to be misunderstood. The phonetic spelling is as follows: "Barts, Baker-Affirm-Roger-Tare-Sail." The phonetic alphabet is also used in the transmission by telephone of coded messages. For example, the code group XISV is transmitted as "X-ray-Inter-Sail-Victor."

Q. Give some pointers which will increase the efficiency of receiving messages. *A.*

(1) Keep the mind on the message; a person cannot receive correctly when he is thinking of something else.

(2) Keep the receiver close against the ear.

(3) Do not interrupt the sender except in cases where not to do so would be of serious disadvantage to the correct reception of the message.

(4) Repeat all messages received. Where messages are long, repeat each sentence as it is sent. When any part of a message is not

understood, call "Repeat," and continue to have the message transmitted until it is understood.

Q. How is the telephone answered when it rings? *A.*

(1) Give the official designation or name of the station.

(2) Give the official designation of the person answering.

Q. What is a flash message? *A.* A message used to indicate the approach of aerial targets. The indication of the target is preceded by the word "flash" repeated three times, and the report is given twice without waiting for an acknowledgment.

Q. Do flash messages follow a particular form? *A.* Yes, they must follow a form and no unnecessary words should be used.

Q. What information is contained in a flash message? *A.*

(Front)

FORM FOR FLASH MESSAGE

(AAAIS)

Organization _____

Serial No._____ Date_____ How sent_____

Time sent_____ To_____

Observation post	Number of airplanes	Type of airplanes	Time seen or heard	Altitude	Sector in which flying	Direction of flight
1	2	3	4	5	6	7
	One	Heavy bombardment.		Very low		North.
	Two	Observation		Low		NE.
	Three	Pursuit		Medium		East.
		Light bombardment.		High		SE.
OP	Several	Airplane				South.
						SW.
	Many					West
						NW.

NOTE.—Very low—below 500 yards; low—500 to 2,000 yards; medium—2,000 to 4,000 yards; high—above 4,000 yards.

Both sender and receiver check off items where possible and save time.

Q. How are altitudes classified? *A.* High—above 4,000 yards; medium—2,000 to 4,000 yards; low—500 to 2,000 yards; very low—below 500 yards.

Q. What record is made of a flash message? *A*. The sender of the message, the operators who transmit it, and the units which receive it, usually record the message by checking the proper words and filling any appropriate blank spaces on a message form.

42. Laying wire, making connections, and tests.—*Q*. What common types of wire are used in field installations? *A*. Two types, both twisted pair—W–110 and W–110B.

Q. Describe each type. *A*. Type W–110 wire has rubber compound insulation covered with weatherproof braid. There are 7 strands, 5 steel and 2 copper. Its weight is 132 pounds to the mile. Resistance is 130 ohms per mile.

Type W–110B is similar to W–110 but has 4 steel and 3 copper strands. Its weight is 132 pounds to the mile. Resistance is 95 ohms per mile. (The candidate should be able to identify either type of wire by looking at it. Arrange a pile of short pieces of different types of wire and let the candidate make his own selection.)

Q. What means are provided for laying wire? *A*. The wire is carried or laid by any one of the following means, depending upon the conditions of the roads, terrain, and traffic, and character of hostile fire: motor trucks; especially constructed horse and motor-drawn carts and reels; reel carts, hand-drawn or towed behind communication carts; breast reels; spools or coils carried by hand. If issued on wooden spools, wire may be laid by inserting an iron bar through the spool and paying off from it, or the wire may be rewound onto a spool of special design provided for the purpose.

Q. What is the present standard reel? *A*. The reel unit RL–31.

Q. Describe the reel unit RL–31. *A*. It is a portable wire-laying and recovery device. It may be used in any one of several ways as follows:

(1) Carried litter fashion between two men.

(2) Pushed or dragged along the ground by one man, wheelbarrow fashion, the reel rims acting as wheels.

(3) Mounted inside or on the extended tail gate of any vehicle which provides the required space. Foot fittings are provided for mounting.

(4) Set up on the ground for unreeling or reeling in the wire.

(5) Mounted outside any vehicle by attachment to the outside of the tail gate.

The unit has a removable brake which may be mounted to either end of the axle. Wire is reeled in by means of a crank which may be placed on the end of the axle.

Q. What is the capacity of the reel unit RL–31? *A*. One 1-mile reel (type DR–5) or one or two ½-mile reels (type DR–4) of wire W–110 or W–110B.

Q. In laying wire should the lines be pulled as tightly as possible or laid loosely? *A.* The lines should be laid loosely in order that the wire may lie flat on the ground, so as to provide sufficient slack for repairing breaks. At suitable intervals, lines should be attached to objects such as trees or posts in order to leave sufficient slack, and to prevent the wire from being pulled into traffic lanes.

Q. How should a traffic lane be crossed in laying wire? *A.* Where possible the lines should "cross roads" through the culverts. The wires are passed through the culvert and tied up at the entrance and exit to prevent immersion in the water. When it is

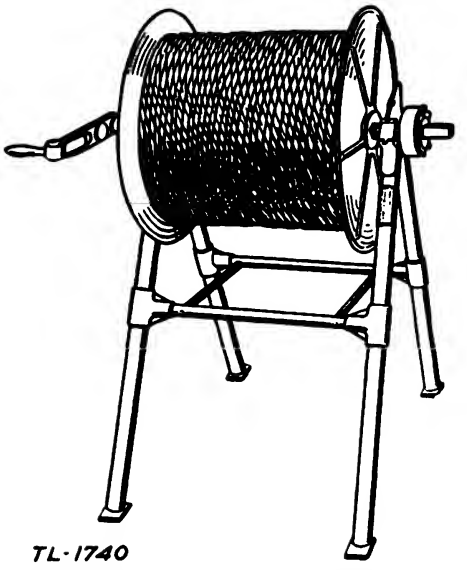


FIGURE 35.—Reel unit RL–31 with reel DR–5.

necessary to carry the wires overhead they should clear the crown of the road by 14 feet. When a line crosses a road between poles or other vertical supports, the wires should be tied at the base and top of the support on each side of the road. The strain which occurs along the line is met by the tie at the base. If neither of the above methods can be used, the line wires should be buried in a trench, crossing the road at right angles. The wires must be laid snug and well secured at both ends of the trench to prevent their being pulled out.

Q. In laying the wire, at what intervals should it be tested? *A.* It should be tested just after making each splice through the splice, when laying wire in the field. In the case of wire on a reel, a test should be made before the reel is taken out of storage.

Q. Given two pieces of field wire, describe and illustrate how to make a standard field wire splice. *A.* To obtain a uniform stagger in making the splice, measure back one plier's length (about 6 inches) from the end of one conductor and cut it at this point. Cut one wire of the other pair in the same manner. Crush the insulation on each conductor, starting at about 6 inches from the end and extending back to 2 inches from the end. Use the heel of the pliers for crush-

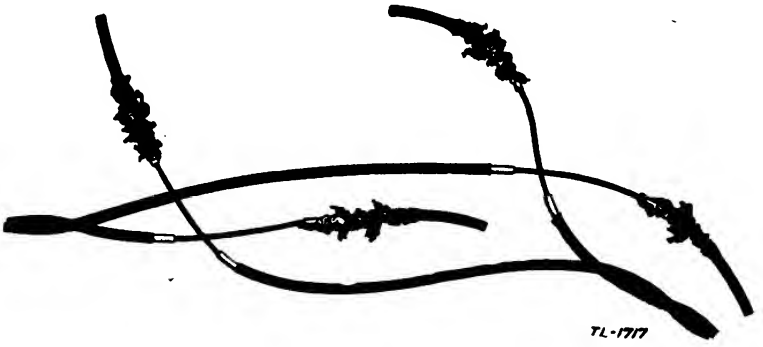


FIGURE 36.—Wires skinned and ready for square knots.

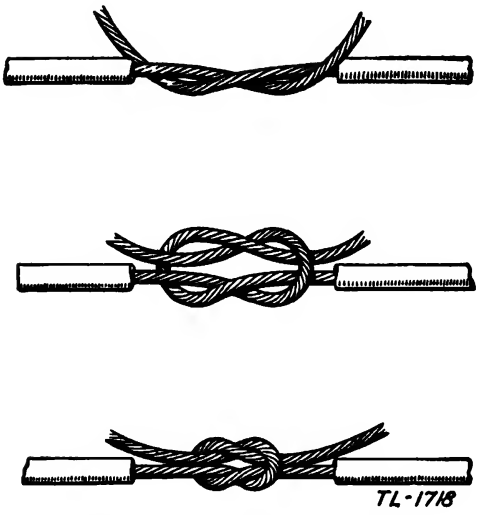


FIGURE 37.—Tying square knot.

ing. Score or ring the crushed insulation at a point about ½ inch from where the crushing began, with the cutting edge of pliers. Using the pliers, skin the crushed insulation off each conductor, being careful not to damage the strands. Clean the strands with the back of the screw driver blade of the electrician's knife. Now tie the long and short conductors together, using a square knot so that the knot occurs about ¼ inch from the insulation. Strip the weatherproof braid from the insulation about ½ inch on each side

of the knot. Insert a 6- to 8-inch piece of 19-gage bare copper seizing wire in the knot and pull the knot tight. Bend the seizing wire at the middle and make 2 or 3 turns on either side of the knot to bind the ends of the knot. Cut the free ends of the conductors flush with end of insulation. Wrap the seizing wire to left and right of the knot until 2 turns are taken over the insulation. Cut off the excess

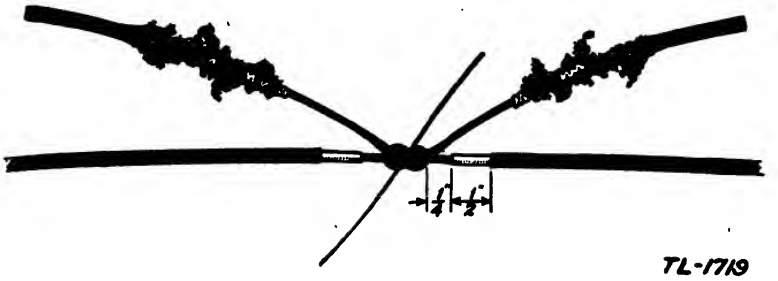


FIGURE 38.—Seizing wire inserted through knot.

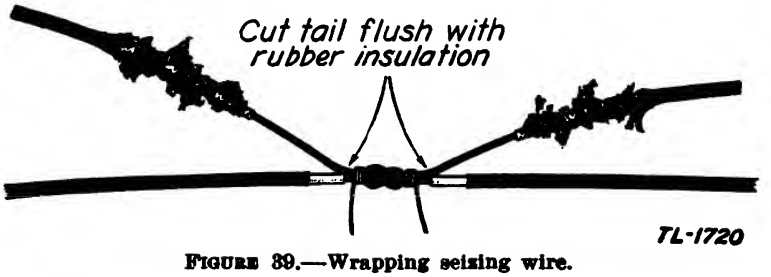


FIGURE 39.—Wrapping seizing wire.

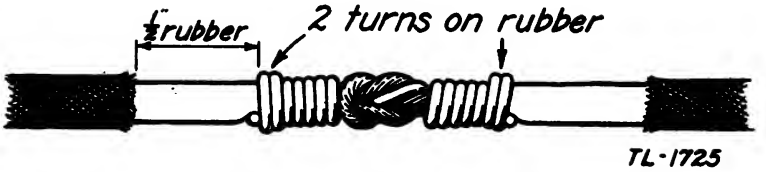


FIGURE 40.—Splice on one conductor after seizing is completed.

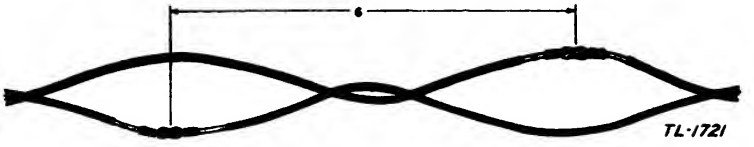


FIGURE 41.—Splice ready for taping.

wire and press ends of seizing wire into the insulation. Apply 2 layers of rubber tape followed by 2 layers of friction tape.

Q. When joints cannot be taped, what should be done to prevent short circuits and grounds? *A.* The joints should be staggered and raised off the ground.

Q. What telephones are furnished for field use? *A.* Signal Corps field telephones EE–5, EE–8, and EE–8A.

Q. How are these telephones classified, i. e., as local or common battery types? *A*. EE–8, either local or common battery; EE–8A, either local or common battery; EE–5, local battery only.

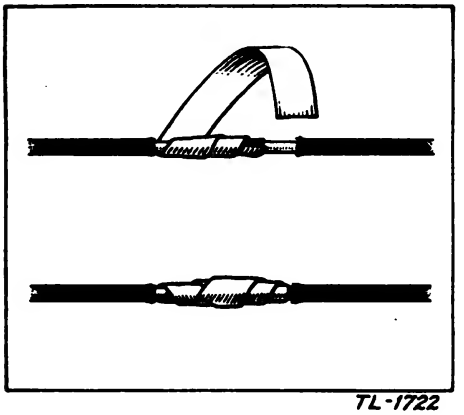


FIGURE 42.—Applying rubber tape.

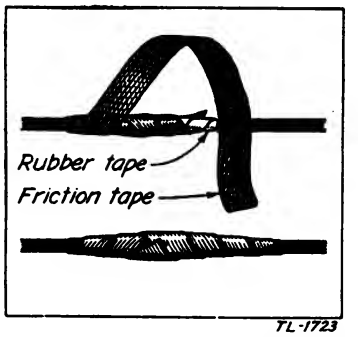


FIGURE 43.—Applying friction tape.

Q. Name the principal circuits of a local battery telephone. *A*. The primary circuit, which consists of the transmitter, battery, and primary winding of the induction coil. The secondary circuit, which

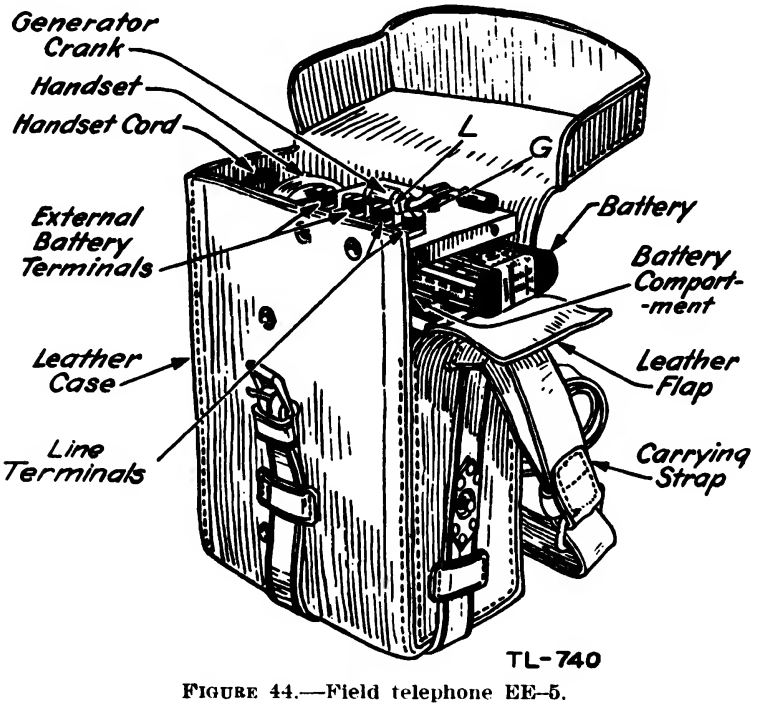


FIGURE 44.—Field telephone EE–5.

consists of the receiver, condenser, and secondary of the induction coil. The signaling circuit, which consists of the generator and ringer. These circuits are basic in all local battery telephones. Certain tele-

phones, such as the EE–8 and EE–8A, will have additional circuits, but in any case these additional circuits supplement the above basic circuits.

Q. How is the signaling circuit connected? *A*. The circuits of both the generator and the ringer are bridged in parallel across the line terminals.

Q. Does the battery current flow through the signaling circuit? *A*. No. The circuit through the generator is always open except when the crank is turned. A condenser in the ringer circuit prevents the battery current from flowing through the ringer.

Q. Does the current from the generator flow through the receiver and transmitter? *A*. The hand-set switch must be operated in order to complete the circuit through the transmitter. Hence, the generator current will not ordinarily flow through the transmitter. The re-

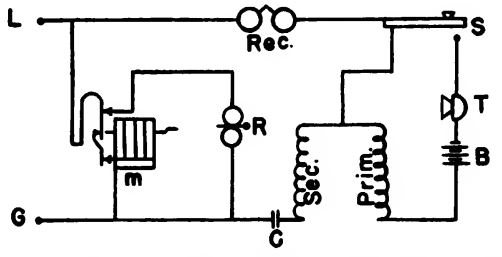


FIGURE 45.—Circuit diagram, EE–5 telephone (modified).

ceiver is always connected across the line, so that generator current could flow through it. However, the resistance of the receiver circuit to low frequency currents is very high. The generator produces alternating current at 20 cycles or less per second. Hence, very little of the generator current will go through the receiver circuit.

Q. How are the batteries installed in the EE–8 and EE–8A telephones? *A*. Remove the hand-set from the carrying compartment. Place two batteries BA–30 in the battery compartment (see fig. 44), being sure that the bottoms of the batteries rest on the springs and that the tops of the batteries rest against the contacts at the top of the compartment.

Q. How is the battery installed in the EE–5 telephone? *A*. One battery BA–9 (4½ volts) is inserted in a spring clip just below the top of the frame (see fig. 44). The battery is covered by the leather flap formed by one side of the case. Two screws which hold this flap to the frame must be removed to insert the battery, after which the screws should be replaced.

Q. How is the station opened when using an EE–8 or EE–8A telephone? *A*. Open the case and remove the hand-set from the carrying

compartment. Place the batteries in the battery compartment. Connect the ends of the line to the terminals marked L1 and L2. With a screw driver turn the screw switch to the proper position, depending on whether the telephone is to be operated by local battery or by common battery. There are about 1½ turns of the screw switch between the local battery and common battery positions. If using local battery, call the switchboard, using the generator. If using common battery, removal of the hand set from its position on the lever switch will call the switchboard. Report the designation of the

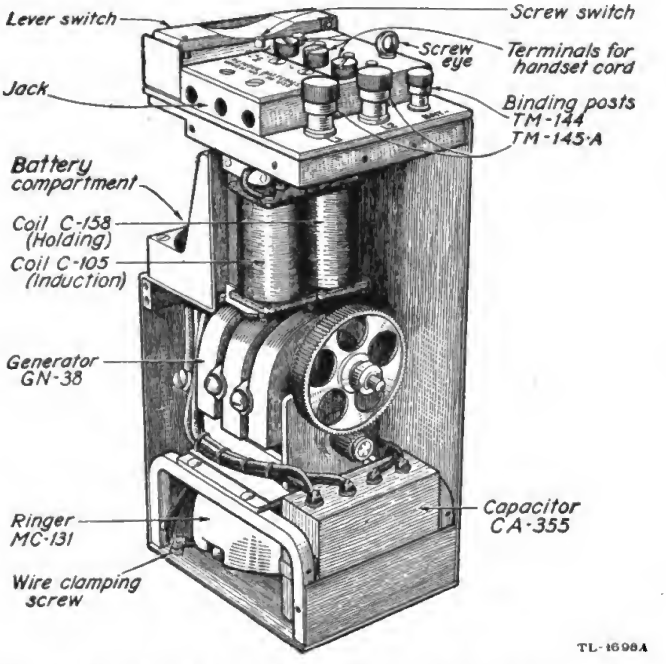


FIGURE 46.—Field telephone EE–8 with side plates removed.

station and request a ring back. If using common battery it will be necessary to replace the hand set on the lever switch before the switchboard can ring back.

Q. How is the station opened when using an EE–5 telephone? *A*. Open the cover of the telephone. Remove the crank from the clamp on top and screw it on the magneto shaft which extends out of the side of the case. Remove the hand set from the carrying compartment. Connect the ends of the line to the terminals marked L and G. Call the switchboard by turning the crank. Report the designation of the station and request a ring back.

Q. How is the station closed? *A*. Report the fact of closing to the switchboard. Disconnect the line from the terminals. With the EE–5 remove the crank and place it in its carrying position. If the telephone

is not going to be used again *immediately*, remove the battery or batteries. Wrap the cord about the hand set and replace the hand set in the carrying compartment. If the batteries were left in the telephone, be sure that the cord does not operate the hand-set switch.

Q. Demonstrate hooking up two telephones to a length of wire and establish communication. (Local battery only.) *A*. (Practical demonstration proved by actual communication.)

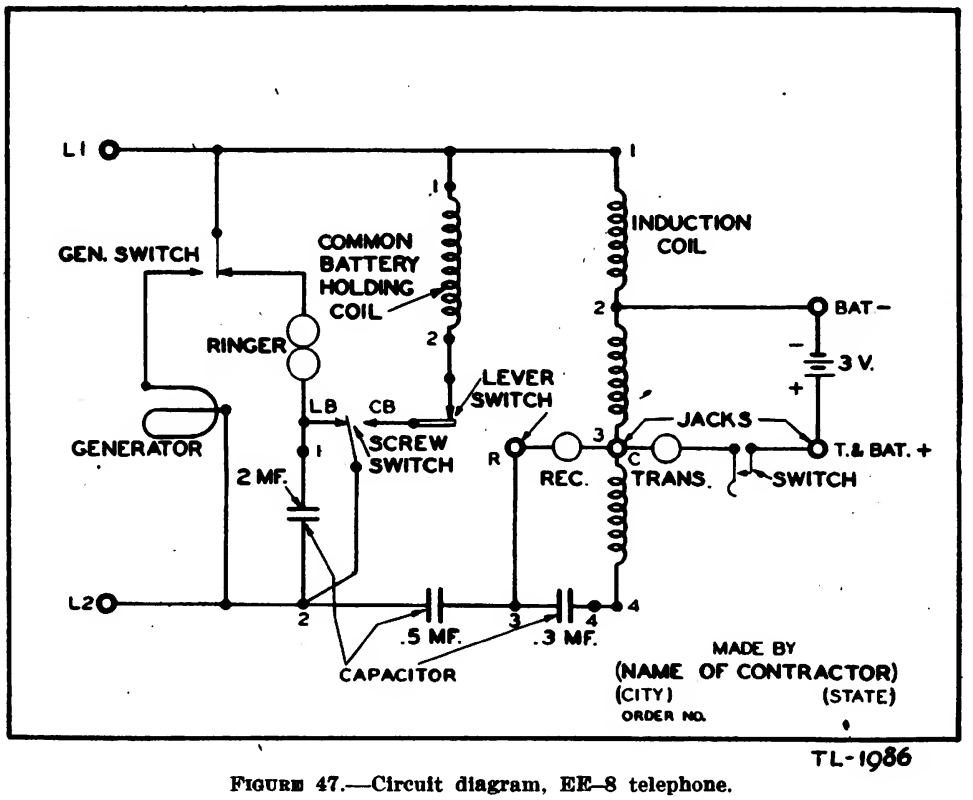


FIGURE 47.—Circuit diagram, EE–8 telephone.

Q. Is it necessary to operate the hand-set switch in order to listen? *A*. No, and furthermore the operation of the hand-set switch when listening only is bad practice as it exhausts the battery rapidly.

Q. How may the battery in a local battery telephone be tested? *A*. If the battery terminals are touched to the tongue, there should be a salty taste noted. Another test is to blow lightly into the transmitter while holding the transmitter switch closed. A distinct sound should be heard in the receiver. In this test the line should be disconnected from the telephone.

Q. When should a telephone be tested? *A*. Always before it is taken out for service. Thereafter the tests are made periodically as prescribed. The fact that circuits are in constant use is indicative that

they are operating satisfactorily. A telephone which is ordinarily very busy and which suddenly becomes quiet should be tested at the earliest opportunity. Communication should never be interrupted to make a routine test.

Q. Name the different types of field switchboards. *A.* BD–14, BD–71, BD–72, BD–9, and BD–11. All types except the BD–14 are monocord switchboards.

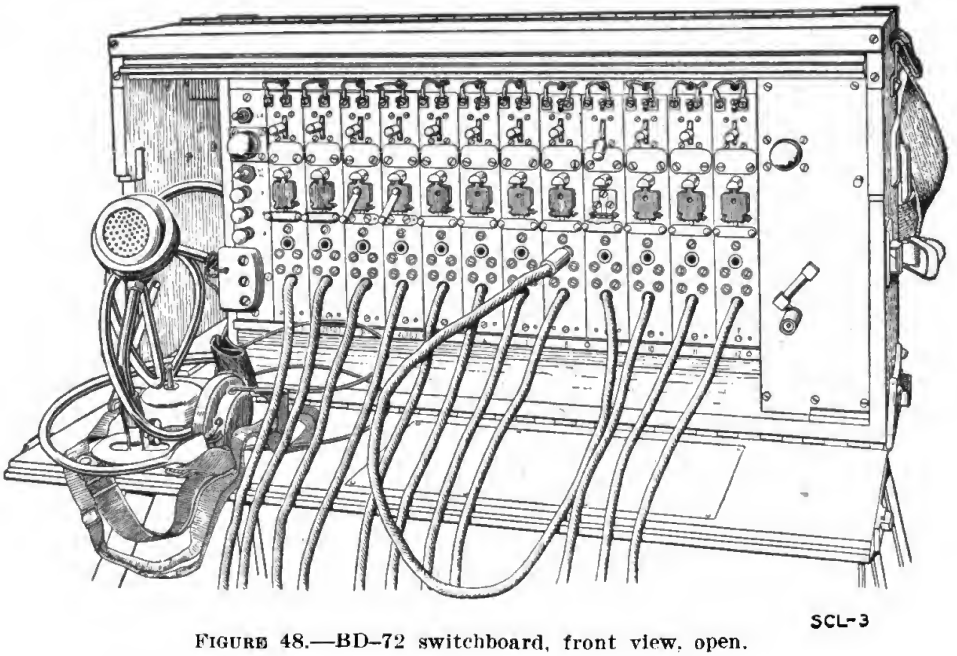


FIGURE 48.—BD–72 switchboard, front view, open.

Q. Describe the BD–71 and BD–72 switchboards. *A.* The switchboard is inclosed in a plywood case mounted on four collapsible steel legs. The unit includes switchboard units, cords, operator's telephone with head and chest sets, lights, switches, and night alarm, batteries BA–30, repeating coils, and terminal strips. Outside of the fact that the BD–71 has only 6-line capacity compared to the 12-line capacity of the BD–72, there is no practical difference between the two switchboards.

Q. Describe the BD–9 and BD–11 switchboards. *A.* The BD–9 has a capacity of 4 lines and the BD–11 of 12 lines. The unit consists of a frame on which the individual drops are mounted. Operator's telephone, terminal strips, repeating coils, and similar items are all separate from the switchboard. A fiber carrying case is provided for the protection of the switchboard when not in use.

Q. Demonstrate hooking up a telephone, a length of wire, and a BD–71 or BD–72 switchboard. *A.* (Practical demonstration proved by actual functioning.)

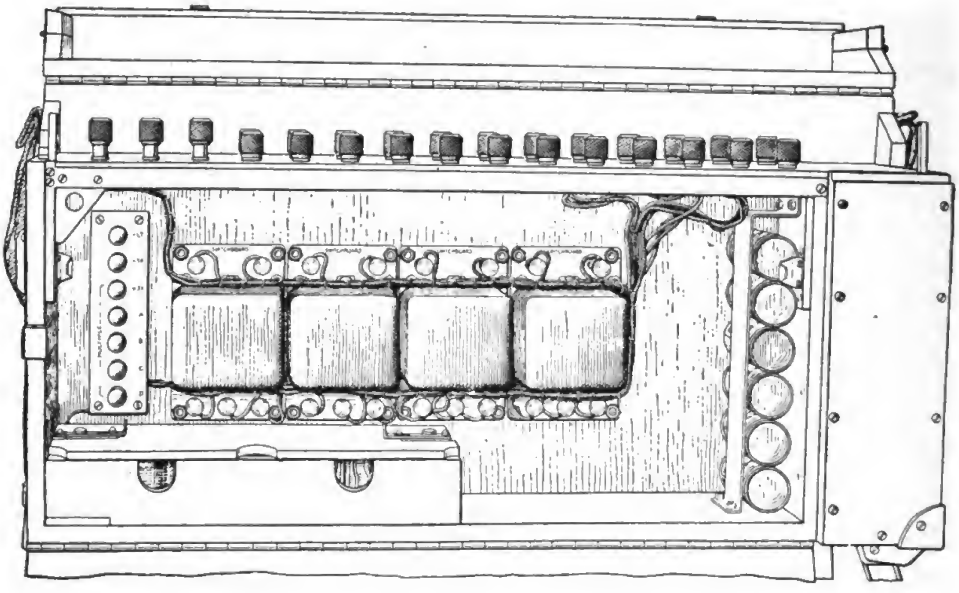


FIGURE 49.—BD–72 switchboard, rear view, open.

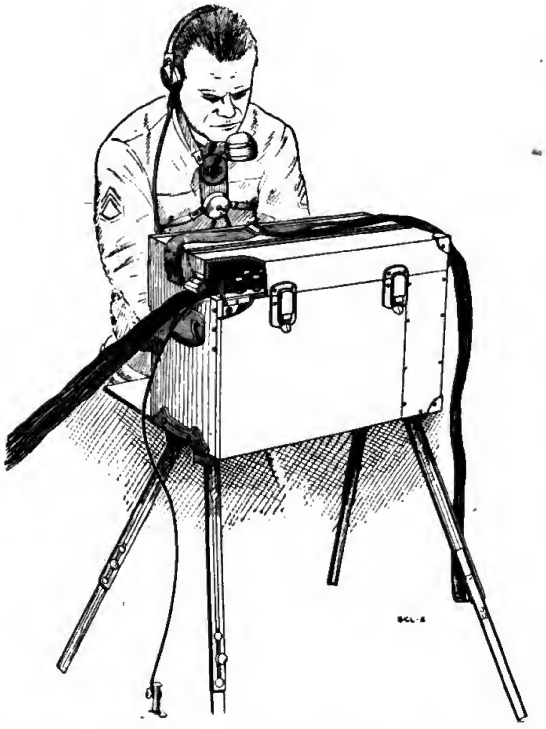


FIGURE 50.—Switchboard BD–71 set up for operation.

Q. Demonstrate hooking up an operator's telephone, battery, night alarm, and one line with telephone connected to a BD–9 or BD–11 switchboard. *A*. (Practical demonstration proved by actual functioning.)

Q. What is the purpose of the ground wire? *A*. Protection against lightning. An air spark gap is incorporated in each unit. The ground wire grounds one side of the lightning arrester.

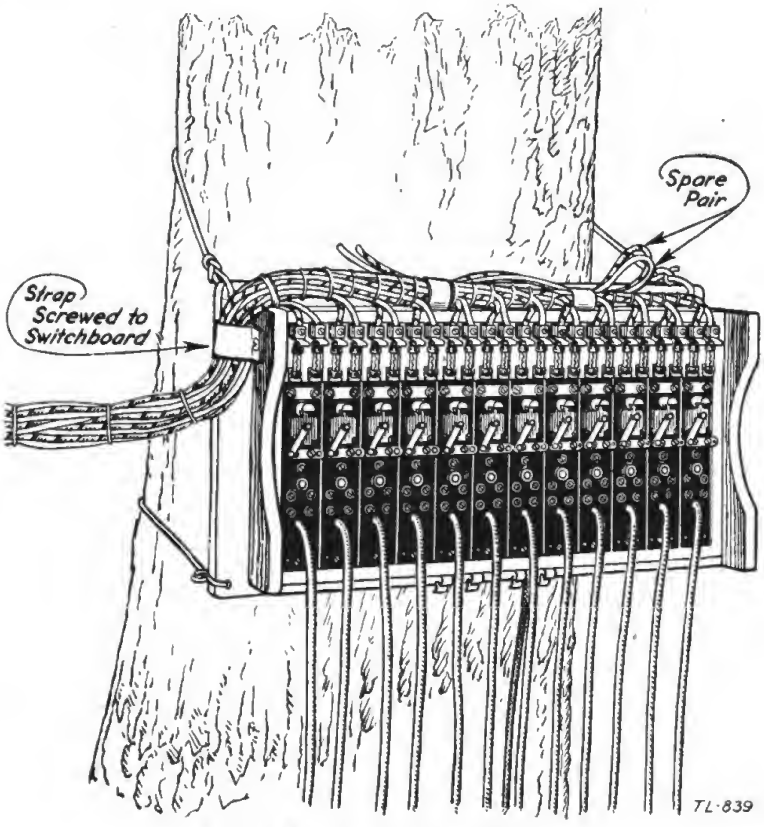


FIGURE 51.—Switchboard BD–11.

Q. Is it desirable for the operator to keep his telephone connected to two lines which are in use? *A*. No. The extra load which his telephone puts on the lines will impair transmission between the two telephones which are in use.

Q. How does the switchboard operator know when someone is calling the switchboard? *A*. Ringing current on the calling line operates the shutter coil and allows the shutter to drop to the horizontal position. If the night alarm switch is closed, the shutter cam will close the night alarm circuit and cause the alarm to operate as long as the shutter is down.

Q. What does the operator do when he sees the shutter drop on one of the units? *A*.

(1) If using a BD–71 or BD–72 switchboard, the operator depresses the ring-talk key on the unit calling. He identifies the switchboard by name and determines the number desired by the party calling. He then restores the calling party's key, and rings the called party by raising the ring-talk key on that unit and turning the generator handle rapidly several times. He next depresses the called party's ring-talk

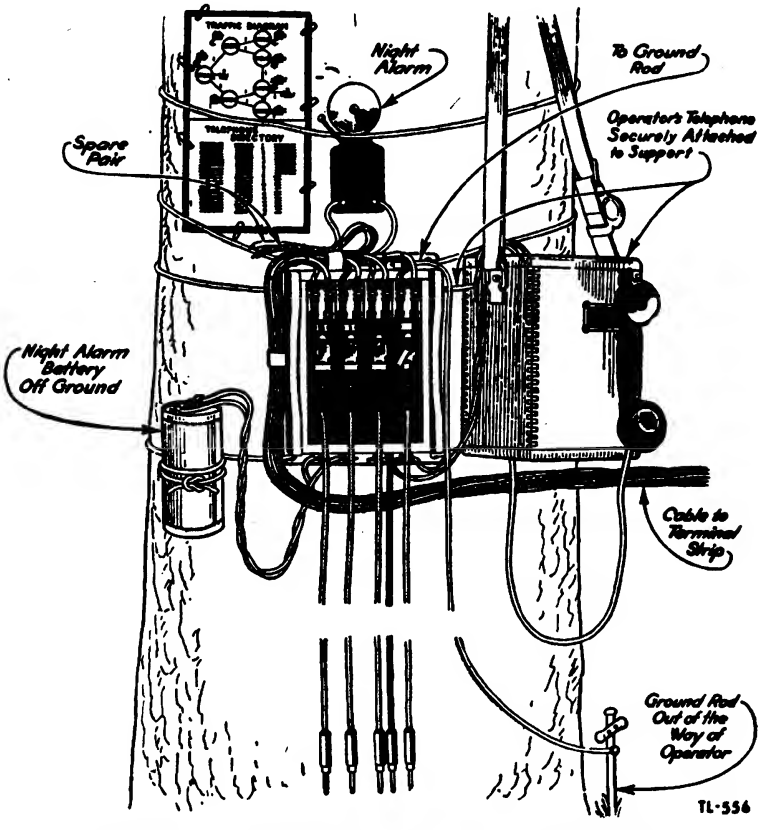


FIGURE 52.—Switchboard BD–9 set up for operation.

key to the talk position and inserts the calling party's plug in the jack of the called party. While the ring-talk key is in the talk position the operator's telephone is bridged across the connection, allowing him to supervise the call. The calling party's shutter is left in the dropped position until the call has been completed. A shutter down indicates that the call has not been completed and that further supervision of the connection is necessary.

(2) If using the BD–9 or BD–11, the operator inserts his plug in the calling party's jack, identifies the switchboard by name, and determines the number desired by the calling party. He places the operator's plug in the jack of the called party and turns the generator of the operator's telephone. He then inserts the called party's plug in the

jack of the calling party. The operator leaves his plug in the jack until he finishes supervising the call at which time he removes his plug and restores the shutter on the calling party's unit.

Q. Why must the switchboard be upright when in operation? *A.* The shutter drops by gravity. If the board is not upright or inclined slightly forward, the shutter cannot drop.

Q. What are some of the troubles which may occur in a telephone system, and what are the tests and remedies? *A.* See table at end of this chapter.

Q. Describe and demonstrate how to test a telephone. *A.* Install the battery. Holding the receiver to the ear, blow steadily into the transmitter while alternately operating and releasing the hand-set switch. The blowing should be very audible as long as the hand-set switch is at the on position. Holding the receiver to the ear, operate the generator. The handle should be easy to turn and the impulses should be heard in the receiver. The ringer should not operate. Short circuit L1 and L2 and turn the generator again. It should now be hard to turn as though a drag had been placed on it, the impulses should be heard in the receiver, and the ringer should not operate. Remove the short. Connect the telephone to another telephone known to be serviceable. Turn the generator on the other telephone. The ringer of the telephone being tested should operate.

Q. What repairs are telephone operators authorized to make? *A.* With the exception of changing batteries, cleaning contacts which are accessible without taking down the telephone, and changing the head set or hand set, the operator is not authorized to make any repairs.

Q. How can most telephone troubles be avoided? *A.* Most of the troubles in telephone communication can be avoided if telephones are carefully used and cared for and are examined and tested before being taken out for service each day. In addition, the batteries must be in good condition, and care must be taken to see that all joints make good contact, including all splices in the lines.

Trouble	Possible cause	Tests and remedies
Home station cannot ring distant station.	(1) Improper line connection at telephone.	(1) Examine connections. Clean and tighten if necessary.
	(2) Open circuit in line.	(2) Examine line for breaks.
	(3) Generator out of order.	(3) Test the telephone at the home station. Repair or replace, as may be necessary.

Trouble	Possible cause	Tests and remedies
	(4) Receiving circuit open, or damaged receiver.	(4) Test the telephone at the distant station. Repair or replace, as may be necessary.
	(5) Ringer at the distant station not functioning.	(5) Test the telephone at the distant station. Repair or replace, as may be necessary.
	(6) Short circuit in line.	(6) A shorted line is usually distinguished by the generator turning hard. Examine the connections and the line. Remove the short when discovered.
Distant station cannot ring home station.	See above.	See above.
Home station can signal distant station but cannot hear distant station talk.	(1) Operator at distant station not operating the hand-set switch.	(1) Operate the hand-set switch properly.
	(2) Battery at the distant station dead.	(2) Test the battery. If weak or exhausted, replace.
	(3) Battery contacts corroded.	(3) Examine contacts and battery terminals. Clean if necessary.
	(4) Broken transmitter cord at distant station.	(4) Disconnect hand set and touch battery terminals with receiver and transmitter cords, being sure that the hand-set switch is operated at the same time. A click should be heard in the receiver if the transmitter cord is all right. Replace cord if necessary.
	(5) Hand-set switch at distant station does not make contact.	(5) Test as in (4) above. Clean and adjust if necessary.
	(6) Carbon in transmitter at distant station packed.	(6) Usually distinguishable by sizzling or crackling noise in receiver. Replace telephone.
	(7) Broken receiver cord at home station.	(7) Disconnect hand set. Touch receiver and common cords to terminals of a battery simultaneously. If a click is heard the receiver circuit is all right. Replace cord if necessary.
Distant station can signal home station but cannot hear home station talk.	See above.	See above.

Trouble	Possible cause	Tests and remedies
Station cannot signal switchboard.	(1) Fuse on switchboard burned out (BD–9, BD–11 only).	(1) Examine fuses and replace if necessary.
	(2) Shutter stuck on its hinge.	(2) Trip shutter by hand. If the shutter will not drop of its own accord, clean hinge.
	(3) Armature holding shutter is out of adjustment or bent.	(3) BD–9 or BD–11: Hold tip of red (operator's) plug against terminals of section being tested. Ring operator's telephone. If the armature vibrates but does not release the shutter, adjust armature until it does. BD–71 or BD–72: Put the plug of an unused circuit across the terminals of the unit being tested. Put ring-talk key to ring position and operate the generator. If the armature vibrates but does not release the shutter, adjust armature until it does.
	(4) Coil of shutter release magnet burned out.	(4) Test as in (3) above. If the armature does not vibrate, the coil is probably burned out. Replace entire unit.
Night bell fails to operate when a shutter drops.	(1) Battery dead.	(1) Test battery and replace if necessary.
	(2) Loose or dirty connections.	(2) Check through all connections. Clean and tighten where necessary.
	(3) Bell contacts corroded.	(3) Examine bell. Clean the contacts if necessary.
	(4) Shutter dropping does not close bell circuit.	(4) Adjust the contacts so the circuit will be completed.
	(5) Bell coils open.	(5) Connect a receiver in series with a battery and the bell coils. When the circuit is closed, there should be a click in the receiver if coils are all right. Replace if necessary.

Chapter 6

MOTOR TRANSPORTATION

43. Nomenclature of major parts of motor vehicles.—*Q.* Into what general groups may the parts of any motor vehicle be divided? *A.* Power plant, transmission system, control system, chassis, running gear, and body.

Q. Point out the principal parts of the power plant to include the crankcase, cylinders, valves, and various parts pertaining to fuel, carburetion, ignition, lubrication, and cooling systems.

Q. Point out the principal parts of the transmission system to include the clutch, transmission, driveshaft, universal joints, differential, torque arms, and axles.

Q. Point out the principal parts of the control system, chassis, and running gear to include frame, springs, brake drum, brake rods, wheels, steering knuckle, drag link arm, emergency and foot brakes.

Q. Why are instruments installed on the dash? *A.* For the purpose of indicating and controlling the operation of the engine and vehicle.

Q. What instruments are usually installed? *A.* Ammeter, oil pressure gage, speedometer, thermometer (engine temperature), choke, light switch, hand throttle, spark control, and ignition switch.

Q. What does the ammeter indicate? *A.* The amount of current that is being consumed by the ignition and light system of the vehicle from the battery, or the amount of current that the generator is supplying to the battery.

Q. What is the normal operating temperature of a gasoline engine? *A.* Approximately 180° F.

Q. Where is this temperature taken? *A.* In the water that surrounds the cylinders and combustion chambers of the engine.

Q. What is the purpose of the oil pressure gage? *A.* To indicate to the operator the pressure under which the oil is being forced from the oil pump.

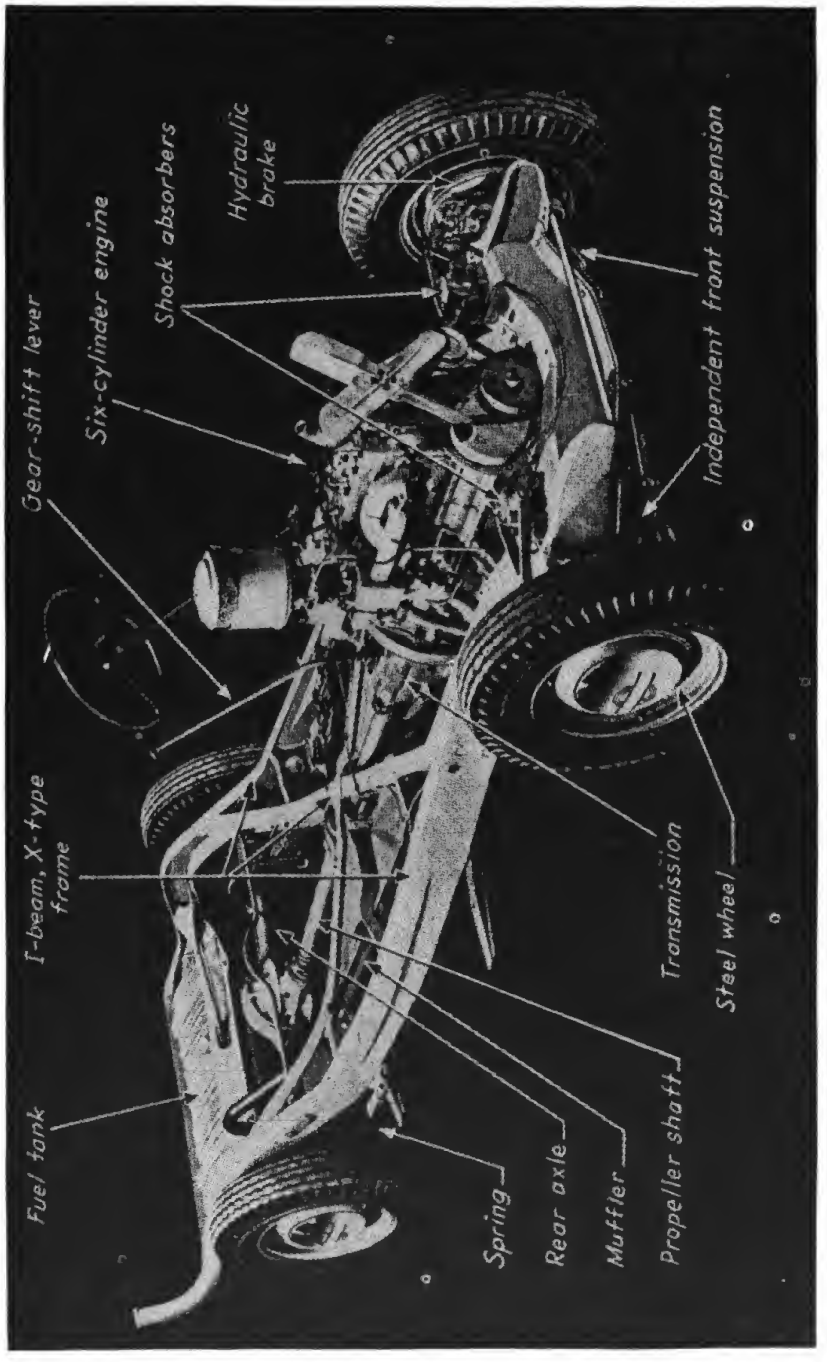


FIGURE 53.—Modern gasoline-engine-driven passenger car chassis showing its various parts.

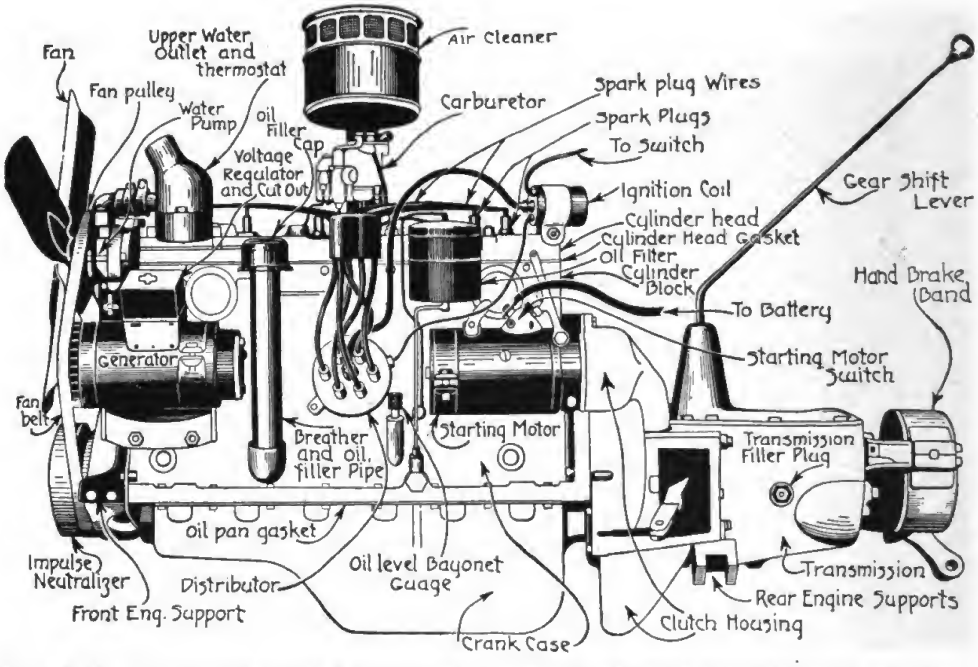


FIGURE 54.—Typical engine and transmission assembly showing external parts, equipment and accessories.

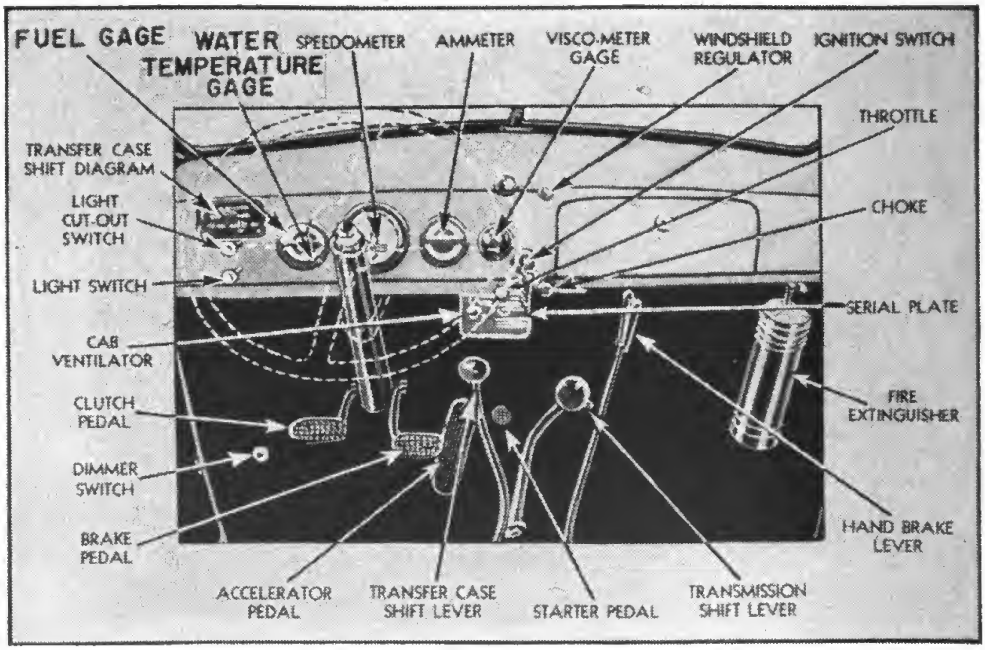


FIGURE 55.—Interior view of truck cab showing instruments and controls.

Q. Does the oil pressure gage indicate that the engine is being lubricated? *A*. No; it only indicates that the pump is forcing oil some place at the pressure indicated by the gage.

Q. What is the purpose of the choke? *A*. To restrict the air passage at the inlet of the carburetor, thereby giving a rich mixture for starting and warming up the engine.

Q. What data are usually found on the dash plate? *A*. Make and model of vehicle, maximum speed, tonnage that the vehicle was designed to carry, engine number, serial number, and date of manufacture.

44. Practical operation of motor vehicles to include driving and fueling.—*Q*. What are the qualifications for a good driver? *A*. Good physical condition and common sense.

Q. Define common sense in connection with driving. *A*. Alertness, judgment, and caution on the road. A good driver will obey all traffic regulations and carry out the rules of good maintenance driving. He will respect the rights of other drivers and of pedestrians.

Q. List a few rules that will help to prevent accidents. *A*.

(1) Have vehicle under control at all times.

(2) Never exceed the prescribed speed limits.

(3) Obey all traffic regulations and special instructions.

(4) Never depend on what the other operator or pedestrian may do.

(5) Never operate a vehicle with faulty brakes, steering mechanisms, or lights.

(6) Always use the proper signals.

Q. How should a vehicle be loaded? *A*. The load should be distributed equally, fore and aft, and to the right and left of the center of gravity of the vehicle. It should be systematically loaded to facilitate delivery. Any load beyond the capacity of the vehicle should be refused. The load should be properly secured. Red flags or lanterns must be attached to all loads protruding beyond the truck body.

Q. What inspections are required to be made by the driver before leaving and after returning to the garage? *A*.

(1) Oil lever in crankcase.

(2) Water in radiator.

(3) Gasoline supply.

(4) Condition of tires and battery.

(5) Inspection for leaks in cooling and oiling systems.

(6) Mechanical condition of vehicle, especially brakes (steering), lights, and horn. Any faults and unusual noise observed during operation should be reported to dispatcher immediately.

Q. Give several common faults in driving which are damaging to the vehicle? *A*.

(1) Racing the engine at any time.
(2) Inadequate use of the gears.
(3) Excessive or improper appliance of the brakes.
(4) Riding, slipping, or quickly engaging the clutch.
(5) Turning front wheel, while standing.
(6) Excessive use of the choke.
(7) Excessive speed in first or second gears.
(8) Continuing to drive with minor maladjustments.

Q. What precautions should the driver take against fire? *A*.

(1) Never refuel while engine is running.

(2) Be careful not to let the fuel tank overflow, as hot exhaust pipe and manifold can readily ignite the fuel.

(3) Keep old oily rags, waste, and papers from under the seat.
(4) Keep engine clean.
(5) Do not smoke while driving or on the vehicle.

Q. What should be done in case a vehicle catches fire? *A*. If the vehicle is inside a building, push it out, if possible. Use the fire extinguisher that is carried on every Government vehicle, playing it directly on source of fire. Do not use water on a gasoline or oil fire; it only tends to spread it. If the fire extinguisher is not sufficient to extinguish the fire, use dirt, sand, or mud; in some cases it can be smothered by using such articles of clothing as may be available. If fire should break out in the load of the vehicle, remove load until the source of the fire can be reached.

Q. What precautions are necessary in cold weather? *A*.

(1) Keep a check on antifreeze solution in radiator.

(2) Watch condition of battery, as it does more work and is less efficient in cold weather.

(3) Never add cold water to an overheated engine.
(4) Never drive fast on slippery roads.
(5) Use chains or tractioneers when necessary.
(6) Keep off soft or partially frozen ground.

Q. How should air brakes be applied? *A*. The best possible stop will be made when the brakes are applied at the very start as hard as the speed and condition of the road will permit, and then eased off as the speed is reduced, so that at the end of the stop but little pressure remains in the brake chambers. In easing the brakes off, do not "fan" the brake valve (repeatedly releasing and applying the brakes) as this wastes air pressure.

Q. What inspection of air brakes should be made before starting the vehicle? *A.* Observe the air pressure gage, showing the pressure stored in the reservoir. It must read 40 pounds or over before the air brakes can develop full effectiveness.

Q. What maintenance must be performed by the driver on an air brake system? *A.* Drain the reservoir, daily in cold weather and weekly in warm weather, by opening the drain cock on the bottom.

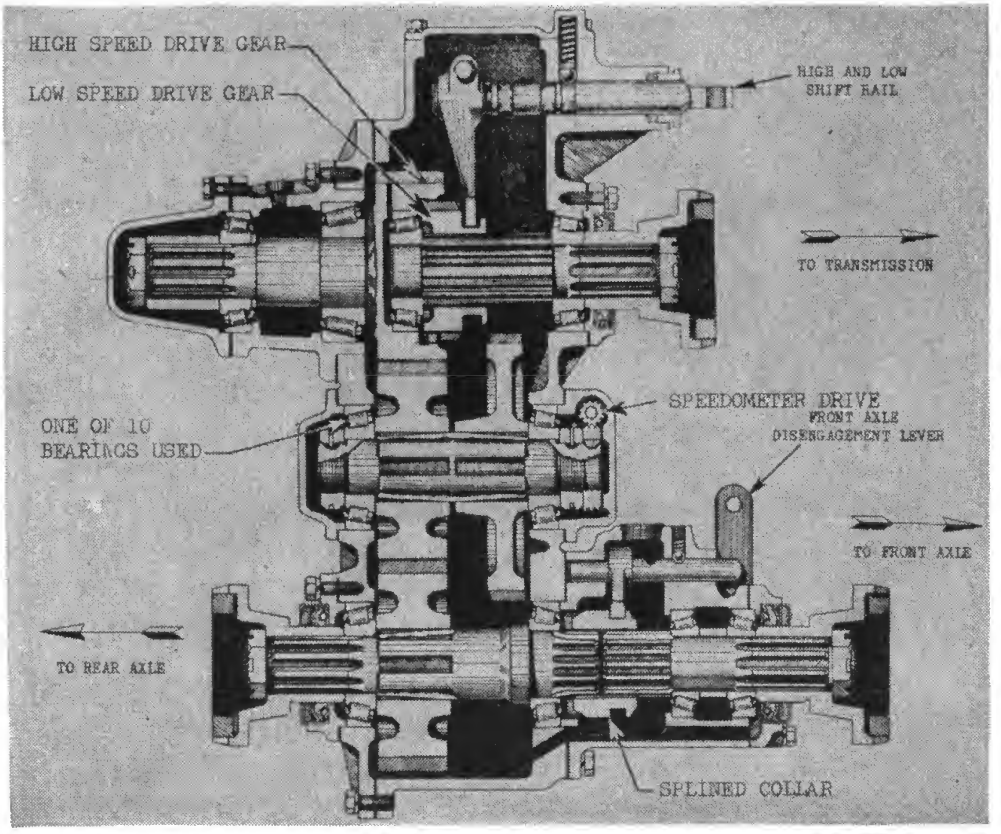


FIGURE 56.—Typical two-speed transfer case showing relation to driving and driven units and disengaging feature for front axle.

This allows any water collected in the reservoir to run out. *Be sure to close the drain cock after the water has been removed.*

Q. What is an auxiliary transmission? *A.* An over-, under-, and direct-drive gearing used in conjunction with the transmission.

Q. How is an auxiliary transmission operated? *A.* When operating under ordinary road and load conditions, it is placed in direct-drive position. When operating under difficult road conditions, or over uneven roads or steep grades with capacity loads, it is placed in the under-drive position. When operating over level roads with

light loads, it may be placed in the over-drive position to give maximum road speed without excessive engine speed.

Caution: The auxiliary transmission must never be shifted while vehicle is in motion.

Q. What precaution is taken before stopping or turning a corner? *A.* Signal to drivers of vehicles behind by holding out the arm. Before turning corners or sharp curves, slow down, sound the horn, and be prepared to stop to avoid collisions with other cars which may be hidden from view. The same precautions are taken at street intersections or crossroads which are not clearly visible for some distance in each direction.

Q. Mention the most important rules to be observed on the road. *A.*

(1) Have vehicle under control at all times.

(2) Always keep a safe distance in rear of vehicle in front so you can stop if that vehicle stops suddenly.

(3) Keep on the right side of the road.

(4) Do not try to pass a car parked or moving on your side of the road if a car is coming in the opposite direction.

(5) Do not try to pass a car on a hill or curve unless you can see the road far enough ahead to assure yourself that no car is coming in the opposite direction.

(6) Sound the horn before passing a car going in the same direction.

(7) Go slowly on sharp curves.

(8) Do not pass street cars taking on or discharging passengers except where safety zones are provided.

(9) Never exceed prescribed speed limits nor the speed limit of your vehicle.

Q. How is a car brought back to the center of the road after beginning to skid on a wet pavement or muddy road? *A.* When the rear of the car starts to skid, turn the steering wheel in the direction the car is skidding and partially close the throttle. To close the throttle entirely would have the same effect as applying the brakes. Do not apply the brakes. When skidding on a narrow road, it is best to apply more power and steer for the center of the road. This will aggravate the skid for a moment but will bring the car around at an angle with the front wheels in the center of the road. The momentum of the car will cause the rear wheels to climb back onto the road.

Q. Should the gas tank be filled while the engine is running? Why? *A.* No. Because of the danger of fire.

Q. What precaution should be observed when filling the radiator when engine is very hot? *A.* The engine should be stopped and allowed

to cool off before adding water. If time will not allow this, let the engine run while water is added slowly (preferably warm water).

Q. How should radiator be protected in cold weather? *A*. Unless filled with antifreeze solution, the radiator and water jackets should be completely drained, when the vehicle is not in use, and a "drain" sign hung on the radiator. Sometimes it will be necessary to protect the lower front half of the radiator with tin or cardboard or canvas. The candidate will be required to—

(1) Start the engine of a truck or car.
(2) Start in first gear, shift into second and third gears.
(3) Shift back into second gear.
(4) Stop the vehicle.
(5) Shift into reverse gear and back the vehicle.
(6) Shift into neutral and stop engine.

45. Duties of driver in care, service, repair, and maintenance of motor vehicle.—*Q*. What defines the duties of the driver? *A*. FM 25–10, Technical Manuals of the 10–series, AR 850–15, Circulars 1–10, OQMG, and the motor vehicle manual issued with each vehicle.

Q. How are drivers selected? *A*. On the basis of their standing in an examination on the course of instruction laid down in FM 25–10.

Q. What are the responsibilities of the driver? *A*.

(1) Operation and maintenance of motor vehicles in accordance with instructions.
(2) Care and condition of vehicle, tools, and equipment.
(3) Loads and loading.
(4) Reports and records.

Q. With what should the driver be thoroughly familiar? *A*.

(1) Fire precautions and fire fighting methods.
(2) Accident prevention.
(3) Purpose of the major units of the motor vehicle.
(4) Motor vehicle controls.
(5) Inspections.
(6) Maintenance.
(7) That part of the motor vehicle manual that pertains to the driver.

Q. How is the vehicle fire extinguisher used? *A*. By removing it from its bracket, unlocking it, and pumping. The stream of liquid must be directed at the top or to the windy side of the flame since the liquid releases a gas which is heavier than air. ***Caution:*** This gas is harmful to breathe.

Q. What may be used to fight a gasoline fire? *A*. Sand or a special extinguisher of the foam, CO_2, or carbon tetrachloride type, but never water.

Q. Where are motor vehicle keys kept when the vehicle is in the garage? *A*. They are kept in the vehicles or on a plainly marked board nearby so that vehicles may be moved quickly in case of fire.

Q. May the driver remove gasoline from his fuel tank? *A*. No. The regulations forbid the use of gasoline for cleaning purposes. Gasoline for all authorized purposes may be obtained on a regular issue slip.

Q. For what accidents are drivers responsible? *A*. All accidents that occur to their vehicles while in motion, when parked in an unauthorized place, or when being worked on by themselves.

Q. How may most operational accidents be prevented? *A*.

(1) By driving carefully and observing traffic regulations.

(2) By the use of an assistant when the driver cannot see where he is moving, as when backing or driving without lights.

Q. What general precautions should be taken by the driver when working on his vehicle? *A*.

(1) He should not start the engine unless the controls are in neutral.

(2) When working under a truck, he should not depend upon jacks but the vehicle should be firmly blocked.

(3) To lessen the danger of fire he should remove the battery in case of doubt or major repair.

(4) He should work in a well-ventilated place.

(During examination the candidate should be required not only to explain the following motor vehicle units and controls but also to demonstrate their proper use to prevent damage to the motor vehicle.)

Q. What is the proper use of the choke? *A*. To assist in starting when the engine is cold or the vehicle has been left idle for some time. Excessive use will flood the engine, making starting impossible and interfere with proper lubrication.

Q. What throttle setting should be used for starting? *A*. This depends upon the vehicle. Most carburetors are designed so that the proper setting for starting is determined by a throttle stop. By stepping on the accelerator a few times before starting, the engine will be primed, and the engine should start when the starter is engaged.

Q. What throttle setting should be used until the engine warms up? *A*. A setting corresponding to about 20 mph vehicle speed. The engine should not carry a load during this period.

Q. What is the proper use of the accelerator? *A*. The accelerator should be depressed slowly. Tramping on the accelerator floods the engine, wastes gasoline, and fouls the spark plugs.

Q. What precautions must be taken with the ignition switch? *A.* It must be left locked, whenever the vehicle is parked, to prevent damage to the coil and battery.

Q. How is the proper spark setting determined? *A.* If the engine runs with full power without knocking, the spark setting is satisfactory.

Q. How do you select the proper gear? *A.* A gear is selected that will allow the engine to run without lugging. If the engine cannot reach its governed speed, gears should be shifted. When descending grades, a gear must be selected that will not force the engine to run faster than its governed speed.

Q. What is the proper way to shift gears? *A.* Bring the engine to full governed speed in each gear as the shift is accomplished.

Q. Can front-wheel drive clutches be used while the vehicle is in motion? *A.* Yes. Levers must not be forced. In some instances the front wheels may have to be turned to allow shifting dogs to come into line. (Drivers of all vehicles should be required to master these special shifting devices.)

Q. What damage might result from the improper selection of gears? *A.*

(1) Engine bearings might be damaged or cylinder head gasket blown.

(2) The driver might be forced to shift down two gears and thus delay the convoy.

(3) If on a down grade the truck might run away or the engine may turn up so fast that it will be damaged.

Q. What care must be taken of the clutch? *A.*

(1) The clutch must not be slipped; gears should be used instead.

(2) When the clutch needs adjustment, a prompt report should be made to the motor sergeant.

(3) The clutch must not be let out suddenly or damage to the whole vehicle will result.

(4) The clutch must be properly lubricated but must not be over-lubricated or it will slip.

Q. Explain double-clutching, and for what is it used? *A.* Double-clutching is accomplished by engaging the clutch while the transmission hesitates in neutral when the gears are being shifted up or down, then shifting to the next gear in the normal manner. During the hesitation period the foot is removed from the throttle if the shift is from a lower to a higher gear; if from a higher to a lower gear the engine is speeded up to the speed that it should be running in the lower gear selected. Double-clutching is useful in shifting from a lower

to a higher gear on trucks that are hard to shift. It is useful in changing to a lower gear preparatory to descending a grade. Double-clutching has its limitations, and the driver must not wait until it is too late to shift. (All drivers should be required to shift from a higher to a lower gear without clashing gears.)

Q. What does the oil gage indicate? *A.* Oil pressure only. The quantity of oil is indicated by the dip stick. Lack of oil or oil pressure is very serious.

Q. What kind of oil should be added to the crankcase? *A.* The kind recommended in the instruction manual.

Q. What is the purpose of the handbrake? *A.* To hold the vehicle in a parked position. In emergency to relieve the foot brake. Caution must be exercised in applying the handbrake because if it is of the propeller shaft type a sudden application may strip the rear end gears and the vehicle will be out of control.

Q. What is the proper way of applying the foot or service brake? *A.* It must be applied, except in case of emergency, with evenly increasing pressure; as the vehicle comes to a stop the pressure should be progressively reduced to give a smooth stop. Sudden stops are hard on the vehicle and on the brakes and may cause rear end collisions.

Q. How are air brakes used? *A.* The same as any other type of brake. The habit of fanning air brakes is dangerous.

Q. Define first echelon maintenance. *A.* First echelon maintenance includes all the maintenance functions required to be performed by the driver and his assistant, using only the tools and spare parts on his truck. It is divided into three parts: inspection, preventive maintenance, and repairs.

Q. What inspections are required to be made by the driver? *A.*

(1) *During operation.*

(*a*) Note abnormal readings of dash gages.

(*b*) Note unusual engine sounds.

(2) *At the halt.*

(*a*) Check for fuel, oil, and water leaks.

(*b*) Check tires, tracks, and traction devices.

(*c*) Check for overheating of mechanical units such as brake bands, transmission, etc.

(*d*) Check lights, horn, windshield wiper, etc.

(*e*) Inspect cargo.

(3) *After operation.*

(*a*) Check all items noted in (*b*) above.

(*b*) Check for loose parts or linkages.

(*c*) Check tools and equipment.

Report results of inspection in each case to the truckmaster.

Q. For what type of maintenance is the driver responsible? *A.* Scheduled, operating, and precautionary maintenance.

Q. What is scheduled maintenance? *A.* Cleaning, lubrication (except when done by a service department), tire care, battey care (except when done by a battery expert), minor repairs, checking of fuel, air, oil, antifreeze, and water.

Q. What constitutes operating maintenance? *A.* Loading, speed, proper use of controls, emergency repairs.

Q. What constitutes precautionary maintenance? *A.* Minor repairs performed as the result of inspections.

Q. What repairs and adjustments may the driver make? *A.* Except for repairing tires and emergency roadside repairs, the driver is not permitted to make any repairs or adjustments except under the supervision of the truckmaster.

Q. How does the driver get needed repairs done to his vehicle? *A.* He turns in a bad order report to his truckmaster. The report may be either written or oral.

Q. What records must the driver keep? *A.* Accident report, trip ticket, bad order report, and in some cases an issue slip and vehicle log. These records are kept as directed by the truckmaster.

Q. How is a vehicle properly loaded? *A.* Proper loading distributes the weight within the body with heavy items on the bottom of the load. The load must be securely lashed, and the vehicle must not be overloaded.

Q. How can the driver tell if the vehicle is overloaded? *A.* By noting the set of the springs.

46. Trouble shooting and minor repairs.—*Q.* What is the most usual cause of engine trouble? *A.* Ignition. In the field, dirt and water in fuel run ignition trouble a close second.

Q. Before making a detailed investigation of engine trouble, what tests should be made? *A.*

(1) That clean gasoline is reaching the cylinders. If in doubt the cylinders should be primed.

(2) That the spark is occurring and all wires are attached.

(3) That compression is satisfactory as tested with the crank.

(4) That ignition timing is approximately correct.

Q. How can a check be made that gasoline is reaching the cylinders? *A.* Disconnect the gasoline line at the carburetor, turn the engine over, and see if gasoline is pumped from the line.

Q. How can it be determined if a spark is occurring? *A.* Turn on ignition, remove one of the spark plug wires, and hold it by its

insulation a short distance from the engine; turn the engine over and note if spark occurs.

Q. How can it be determined if ignition timing is approximately correct? *A.* Remove a spark plug but leave its wire attached and remove valve cover. Through spark plug hole note when piston is at top dead center and at the same time note when both valves are closed. Continue to turn engine over slowly and note when spark occurs. To be correct, spark should occur at or near top dead center with both valves closed.

Q. If the four basic tests are positive but the engine still refuses to start, what may be the trouble? *A.*

(1) Engine flooded.
(2) Choke not working.
(3) Carburetor frozen.
(4) Engine too cold.
(5) Valve sticking open.
(6) Valve spring broken.
(7) Spark plugs dirty or with too wide a gap.
(8) Poor gasoline.
(9) Wiring out of order.
(10) Wet ignition system.
(11) Battery too weak.
(12) Throttle levers disconnected.
(13) Carburetor jet plugged.
(14) Condenser weak.
(15) Oil too heavy.
(16) Blocked muffler.

Q. What does light blue smoke from the muffler indicate? *A.* Burning of oil for some reason.

Q. What does steam from the exhaust indicate? *A.* A water leak due to a blown gasket or cracked engine.

Q. What does black smoke from the exhaust indicate? *A.* Too rich a mixture. Engine will be sluggish when this condition exists.

Q. How does the driver generally locate trouble? *A.* By inspections, generally during operation.

Q. What repair parts should the driver carry? *A.* Tape, wire, tire patching outfit, extra spark plug, and such extra parts as past experience has shown are liable to frequent failure.

Q. What should the driver do when his vehicle is being repaired? *A.* He should assist the mechanic and point out past troubles.

Q. Before performing any repairs what should be done? *A.* The motor vehicle instruction book should be consulted.

Q. What are indications of steering trouble? *A.*

(1) Play or rattle in a steering gear.

(2) Shimmy.

(3) Peculiar or rapid tire wear.

(4) Hard steering.

Q. What does backfiring indicate? *A.*

(1) A lean mixture.

(2) Carburetor or fuel trouble.

(3) Overheating of engine.

(4) Stuck valves.

(5) Retarded spark.

Q. Name some clutch troubles which should be reported? *A.* Slipping, grabbing, noisy clutch, clutch will not release.

Q. When do brakes need adjustment or repair? *A.* When they will not stop the vehicle within 30 feet from 20 mph on a dry, smooth, level road.

Q. When should repairs be made to a vehicle? *A.* As soon as they can be done competently.

Q. What is needed to find trouble on a motor vehicle? *A.* A set of testing equipment such as is furnished for the use of each battery.

47. Convoy and march rules and discipline.—*Q.* What is a convoy? *A.* A group of two or more military motor vehicles moving as a unit under competent military authority.

Q. What is the purpose of a convoy? *A.* The efficient transportation of personnel and matériel, especially with respect to time required and condition upon arrival.

Q. What is the assigned minimum distance for trucks in convoy? *A.*

(1) Open formation: 100 yards.

(2) Closed formation: Twice the speedometer reading in yards.

(3) At halt: 2 yards.

(4) Between sections: 3 to 5 minutes driving time.

Q. Describe drivers' arm signals. *A.*

(1) Turn right: Extend left arm outward at an angle of 45° above the horizontal.

(2) Turn left: Extend left arm outward horizontally.

(3) Slow or stop: Extend left arm outward to an angle of 45° below the horizontal.

(4) Pass and keep going: Extend left arm horizontally and describe small circles toward the front with the hand.

Q. Describe the commands and signals commonly used in a motorized unit. *A.*

(1) Start engine: Simulate cranking.

(2) Ready to start: Senior in truck stands on running board, faces leader, and extends arm vertically, fingers extended and joined, palm toward the leader.

(3) Stop engines: Cross arms in front of body at the waist and then move them sharply to the side. Repeat several times.

(4) Increase speed: Carry closed fist to the shoulder and rapidly thrust it vertically upward several times to the full extent of the arm.

(5) Close up: Extend arms horizontally straight to the front, palms in. Move hands together and then resume first position. Repeat several times.

(6) Open up: Extend arms horizontally straight to the front, palms out. Move hands outward and then resume first position. Repeat several times.

(7) Danger: Use three long blasts of a whistle or automobile horn repeated several times or three equally spaced shots with a rifle or pistol. The person giving the signal points in the direction of impending danger. This signal is reserved for warning of air or mechanized attack, or other immediate and grave danger. Other signals may be found in FM 25–10.

Q. What are the driver's principal duties during a convoy? *A.*

(1) Attention to orders and to his driving.

(2) Constant inspection before, during, and after operation.

Q. What should the driver do if he has any trouble when the convoy is on the march? *A.* If it is a major trouble he should pull to the side of the road and signal the following vehicle to pass. He should then report his trouble to the maintenance officer, who is at the rear of the convoy. If left behind, the driver will remain with his truck as a guard. If it is a minor trouble, he will report it to the section mechanic or maintenance officer at the next halt.

Q. What should the driver do during halts of a convoy? *A.*

(1) Make the inspections prescribed.

(2) Keep to the right of his vehicle.

Q. What are the duties of the assistant driver during a convoy? *A.*

(1) Assists the driver in backing, parking, etc.

(2) Watches to the rear.

(3) Takes his turn at driving.

(4) Assists in first echelon maintenance.

Q. How is gasoline obtained on convoy? *A*.

(1) In an emergency, from 10-gallon cans carried with the convoy.

(2) At halts, from tankers or some type of filling station.

48. Handling trucks under adverse conditions.—*Q*. What equipment is furnished each truck for this purpose? *A*. One tool set (complete with tools) and pioneer equipment motor vehicle set No. 1. This set consists of a shovel, pick mattock, an axe, and a bracket to carry them with, one set of chains, and in some cases traction devices are also furnished.

Q. What other equipment is available? *A*. The maintenance section has a block and tackle set, a wrecking set, towbars, and rope. Some vehicles are equipped with power driven winches, and all vehicles are equipped with towhooks and pintles.

Q. In applying chains what precautions must be taken? *A*. They must be adjusted properly. In the case of all-wheel drive vehicles they must be placed on all wheels, or broken axles will result.

Q. In case your vehicle gets stalled, what do you do? *A*. I, or the assistant driver, investigate the reason for stalling and make a plan as to how best to get out of the position. If my decision, or the decision of some one in authority, is that a wrecker is needed, I await the wrecker.

Q. What four abilities must a motor vehicle have to get out of or keep going in a difficult situation? *A*.

(1) *Power.*—All new trucks issued to the service have enough power.

(2) *Momentum.*—This depends on the speed of the vehicle. In some cases too much speed causes the vehicle to lose part of its traction, resulting in spinning of the wheels. If this occurs the vehicle may become badly stalled.

(3) *Traction.*—All of the multiwheel vehicles are designed to give great traction.

(4) *Flotation.*—This is the ability of the vehicle to ride the ground surface.

Q. How should a difficult hill be negotiated? *A*. On approaching, a sufficiently low gear should be selected to negotiate the hill, and maximum practicable momentum should be obtained. If in column do not start up the hill until the truck ahead has negotiated it. In case of failure, back down in gear. ***Caution:*** Check to see if brakes hold before shifting to reverse gear, and take steps to enable the truck to climb the grade; for example, lower gear, use of traction devices, or tow from a tractor.

Q. What is a prolonge? *A.* It is a rope with a hook or loop on one end used to maneuver a vehicle by manpower. Prolonges are usually used in pairs.

Q. How should very steep, dangerous slopes be descended? *A.* Straight down, with all personnel except the driver dismounted. Gears should be used, and if brakes are also needed care must be exercised to prevent locking the wheels. The ignition should not be turned off. Outside assistance may be needed; for example, block and tackle, winch, or prolonges.

Q. What is the best way to negotiate mud? *A.*

(1) Maintain momentum.

(2) Use highest gear possible.

(3) Apply power gently to prevent wheel slippage.

(4) Use traction devices.

(5) Use care in selecting track.

Q. In case a vehicle becomes stalled in mud what should be done? *A.*

(1) If loaded with personnel, have them dismount and push. Sometimes backing up and selecting another way out will solve the problem.

(2) Use a tow.

Caution: Because of the danger of slipping under the vehicle, personnel should be cautioned against pushing on the side of a moving vehicle that has slipped into a ditch or old wheel ruts.

Q. In case of operating alone what is done if the vehicle becomes stalled? *A.*

(1) Traction may be improved by means of wheel mats, brush, or boards.

(2) The truck may be dug out.

(3) If the vehicle has dual wheels, a rope may be used between the wheels; the truck will wind the rope up like a windlass.

(4) A pole may be inserted between the wheels that are slipping. This method is very effective on tracklaying vehicles.

Q. What is the most useful device furnished the coast artillery for negotiating difficult terrain? *A.* The power driven winch on tractors and gun trucks.

Q. How is sand negotiated? *A.*

(1) Use of traction devices.

(2) Using the same track.

(3) Making roads from chicken wire or brush.

Q. In case skidding occurs what should be done? *A.* The accelerator should be released gradually and the front wheels turned in the

same direction that the rear wheels are skidding. Where necessary, prolonges may be used to prevent skidding in very slippery places.

Q. How is a narrow ditch crossed? *A*.

(1) Small ditches, less than the diameter of the tire, or wider shallow ditches should be crossed at an angle. Since this puts a strain on the vehicle the load should be lightened if possible, and personnel should assist at the critical point.

(2) Wide ditches must be filled or bridged before crossing. They are crossed at right angles.

Q. How are shallow streams forded? *A*. Slowly in a low gear.

Q. What precautions should be observed in crossing bridges? *A*.

(1) The speed and load signs should be observed.

(2) When the capacity of the bridge is not sufficient, the towed load can be pulled across separately.

(3) Track-laying vehicles should be started across so that they do not have to turn.

(4) Brakes should not be used.

Q. When towing over difficult terrain, what precautions must be taken? *A*. If possible, apply the brakes on the tow before applying those of the vehicle. Most vehicles designed for towing now provide means to do this.

Q. If a turn is too sharp for a towed load what may be done? *A*. The tow may be uncoupled and negotiated around the bend with winch or block and tackle.

Q. In case a vehicle overturns what is done? *A*. Remove the load and await a maintenance crew with block and tackle and wrecking set.

Q. What is the best way to keep a vehicle from becoming stalled or mired? *A*. Follow a reconnoitered route and make a careful inspection of all doubtful places before attempting to negotiate them.

CHAPTER 7

ELEMENTARY DEFINITIONS FOR ANTIAIRCRAFT ARTILLERY

49. General.—The definitions listed in this section are intended to give a general knowledge of elements of data and terms applicable to antiaircraft artillery.

Altitude.—The vertical distance to a point in space from a horizontal reference plane, usually the horizontal plane containing the directing point of the battery.

Angular height.—The vertical angle between the line of position (site) and the horizontal.

Azimuth.—The horizontal angle, measured in a clockwise direction, from a selected reference line (usually the grid north line) passing through the position of the observer to the horizontal projection of the line of sight from the observer to the objective.

Back azimuth.—The azimuth plus or minus 180° or 3,200 mils; the opposite direction.

Base line.—A line of known length and direction between the primary (battery) and one of the secondary (flank) observation or spotting stations, the position of which with respect to the battery is known. The base line is called right-handed or left-handed depending on whether the secondary station is to the right or left of the primary station from the point of view of a person facing the field of fire.

Center of burst.—The mean position in space of a particular series of bursts.

Dead time.—The time necessary to compute and utilize an element of the data.

Degree.—A unit of angular measure—a circle is divided into 360 equal parts or degrees.

Displacement.—The distance from one point to another point.

Ground speed.—The linear velocity of the target, usually expressed in yards per second, with reference to the ground.

Horizontal range.—The length of the base of the vertical right triangle in space, the vertical side of which is altitude and the hypotenuse of which is the line of position.

Leveling.—The process of adjusting a gun and mount or an instrument so that all vertical or horizontal angles will be measured in true vertical or horizontal planes.

Line of position.—The line of position, or line of site, of a point is the straight line connecting the point of origin with that point. The point of origin is usually a gun or position-finding instrument.

Line of sight.—The line of vision; the optical axis of an observation instrument.

Line of site.—*See* Line of position.

Mil.—A unit of angular measure; one sixty-four-hundredth part of a circle. For practical purposes the arc which subtends a mil at the center of a circle is equal in length to one one-thousandth of the radius.

Muzzle velocity.—The velocity of the projectile at the origin of the trajectory; also called initial velocity.

Normal.—Geometrically the term means perpendicular to. When used in connection with reference scales, the normal setting is that reference scale setting which corresponds with a true setting of zero.

Orientation.—The establishment of true horizontal lines of known direction; the process of adjusting the azimuth circles of guns or instruments so that they will read correct azimuths when pointed in any direction.

Parallax.—The difference in azimuth or direction of a point as viewed from two other points.

Plane of position.—The vertical plane containing a line of position.

Position finding.—The process of determining the present and future positions of a target for the purpose of directing fire upon it.

Position of the target.—Two positions of the target are considered: Present position is the position of the target at the instant of firing; future position is the predicted position of the target at the end of the predicted time of flight.

Predicting.—The process of determining the expected position of the target at some future time.

Reference numbers.—Arbitrary numbers used in place of actual values in the graduation of certain scales. Their purpose is to avoid the use of positive and negative values.

Sense.—The direction of a point of burst, center of burst, or center of a cone of fire, with respect to the target or other aiming point, as over or short, right or left, above or below.

Slant range.—The hypotenuse of the vertical right triangle in space, the vertical side of which is altitude and the base of which is horizontal range.

Spotting.—The process of determining the position of a point of burst or of the center of a cone of fire with respect to the adjusting point.

Synchronization.—A process in which the values indicated by all receiver pointers of a data-transmission system are made to agree with the values set on the corresponding transmitters.

Symbols.—Letters used to represent certain elements of firing data, angles, or position of the target. For example: ϵ (epsilon), represents angular height; ϕ (phi), quadrant elevation; H, altitude; F, fuze range; and R, horizontal range.

Time of flight.—The elapsed time from the instant the projectile leaves the bore of the gun to the instant of impact (burst).

50. Antiaircraft searchlights.

Acoustic corrections.—Corrections to sound locator data for nonstandard atmospheric conditions and sound lag.

Aerial sound ranging.—The process of locating aircraft by means of the sounds emitted.

Arbitrary corrections.—Corrections to sound locator data which are applied to correct for observed errors after all known deviating causes have been corrected for.

Distant electric control.—A system for the control of the pointing of searchlights from a distance. The system consists of the controller at the control station and the necessary motors or receivers at the searchlight.

Sound lag.—The angular difference between the actual (present) position of the target and the apparent position as indicated by sound.

Zero reader.—A device for indicating when the searchlight is properly pointed on corrected sound locator data.

CHAPTER 8

NOMENCLATURE, ACTION, AND MAINTENANCE OF SMALL ARM WITH WHICH ORGANIZATION IS EQUIPPED AND ITS AMMUNITION

51. Rifle, U. S., caliber .30, M1903.—*a. Nomenclature and action.*—*Q.* By what other name is the M1903 rifle often called? *A.* It is popularly referred to as the "Springfield rifle" because it was first made at the Springfield Armory, Springfield, Mass.

Q. How would you classify it according to its method of operation? *A.* It is a breech-loading bolt action magazine rifle.

Q. What is meant by caliber .30? *A.* Caliber .30 means that the distance between two directly opposite lands in the barrel, expressed in inches, is 30/100 of an inch.

Q. What are the lands and grooves? *A.* The lands are the raised portions of the bore and the grooves are the spaces between the lands.

Q. What direction of twist do the lands and grooves in the bore give the bullet? *A.* A right twist, or clockwise as seen from the breech.

Q. How does this affect the bullet? *A.* The rotation keeps the bullet from tumbling in its flight, but also causes it to drift slightly to the right.

Q. In firing, should any allowance be made for drift? *A.* No. This is automatically corrected for in the construction of the rear sight leaf.

Q. What ranges can be set on the sight leaf? *A.* Ranges from 100 to 2,850 yards.

Q. What is the weight of the rifle? *A.* About 8¾ pounds.

Q. What is the length of the rifle? *A.* About 43 inches.

Q. What is the muzzle velocity of the ball cartridge? *A.* 2,700 feet per second.

Q. What is the muzzle velocity of the guard cartridge? *A.* 1,200 feet per second.

Q. How many shots can be fired without reloading? *A.* The magazine of the rifle will hold five cartridges and one additional cartridge

may be inserted in the chamber, thus making the maximum capacity of the rifle, for any one loading, six shots.

Q. What is meant by the balance of the rifle and where is it located? *A.* As the name implies it is where the rifle balances when held in the hand. It is just below the windage scale and in front of the floor plate.

Q. Point out the following parts:

Barrel.	Slide screw.	Ejector.
Front sight.	Range scale.	Magazine.
Stacking swivel.	Bolt.	Floor plate.
Stock.	Bolt handle.	Guard.
Upper band.	Floor plate.	Trigger.
Lower band swivel.	Sleeve.	Lower band.
Grasping groove.	Firing pin.	Butt swivel.
Hand guard.	Firing pin sleeve.	Butt plate.
Rear sight.	Striker.	Bayonet.
Movable base.	Main spring.	Bayonet guard.
Windage screw.	Extractor.	Bayonet grip.
Windage scale.	Safety lock.	Bayonet catch.
Drift slide.	Cut-off.	Oiler and thong case.
Slide.	Cocking piece.	Brush and thong.

A. See accompanying figures and the rifle itself.

Q. What does the letter "U" on the lower band mean? *A.* If the band is taken off it should be put back with the "U" up, as the band is tapered to fit the barrel and stock.

Q. Explain the working of the extractor. *A.* In loading from the magazine, the hook of the extractor catches in the groove on the cartridge case as the follower pushes it up from the magazine. The hook of the extractor continues to hold the cartridge case against the head of the bolt until the bolt is drawn fully to the rear. When the bolt is rotated and drawn to the rear, the extractor brings the cartridge case back with it.

Q. What does the ejector do? *A.* When the bolt is almost fully back, the top locking lug strikes the heel of the ejector and throws the point of the ejector suddenly to the right. As the bolt continues to move back, carrying the cartridge case with it, the ejector hits the rear face of the cartridge case and throws it out of the receiver.

Q. When firing, how can you tell when the last cartridge in the magazine has been fired? *A.* After the last cartridge has been fired and the bolt drawn fully to the rear, the follower rises and holds the bolt open to show that the magazine is empty.

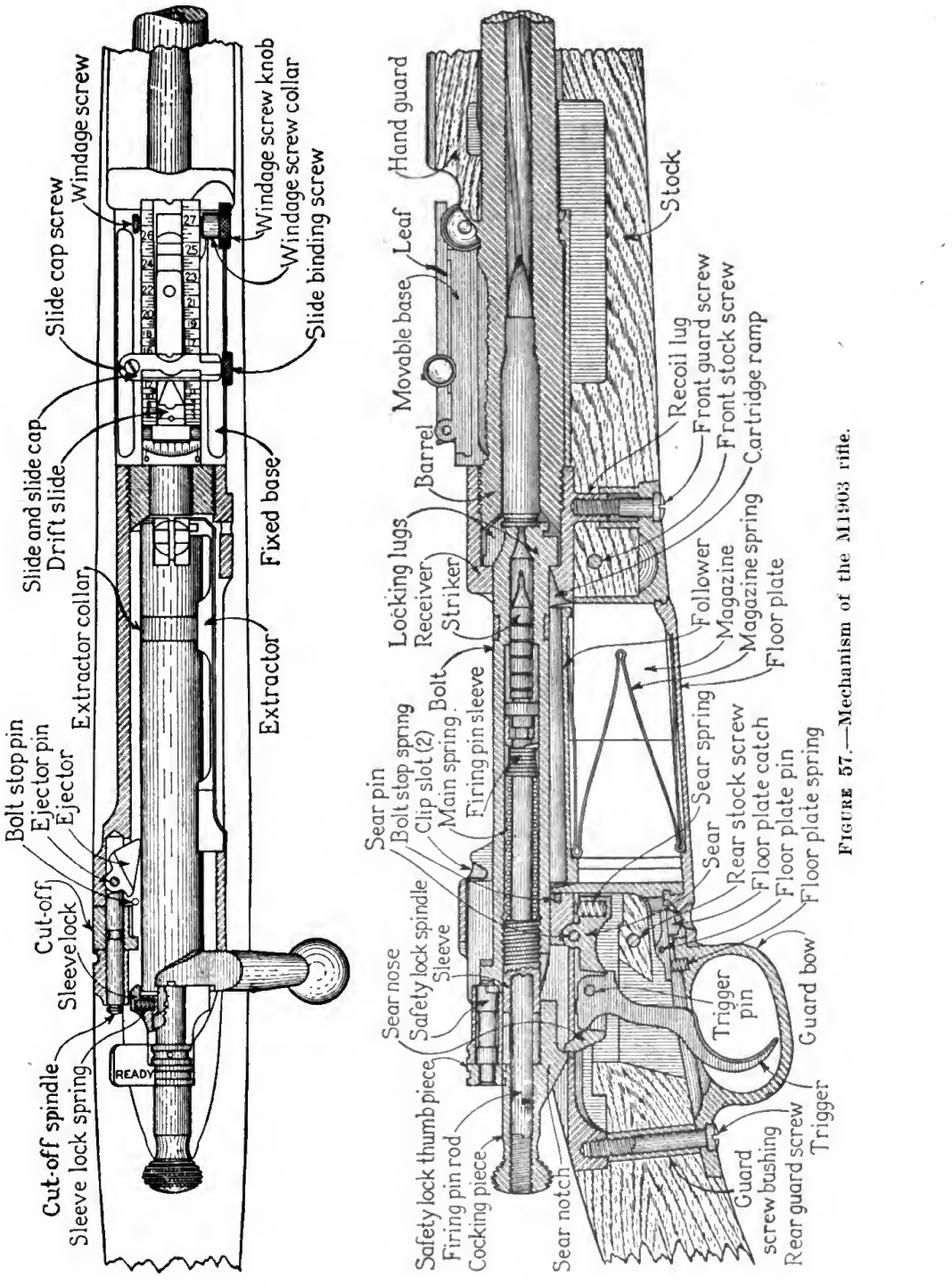


FIGURE 57.—Mechanism of the M1903 rifle.

Q. Describe the normal open sight. *A*. The top of the front sight appears to be even with the top of the rear sight slide, and the front sight appears in the middle of the rear sight notch.

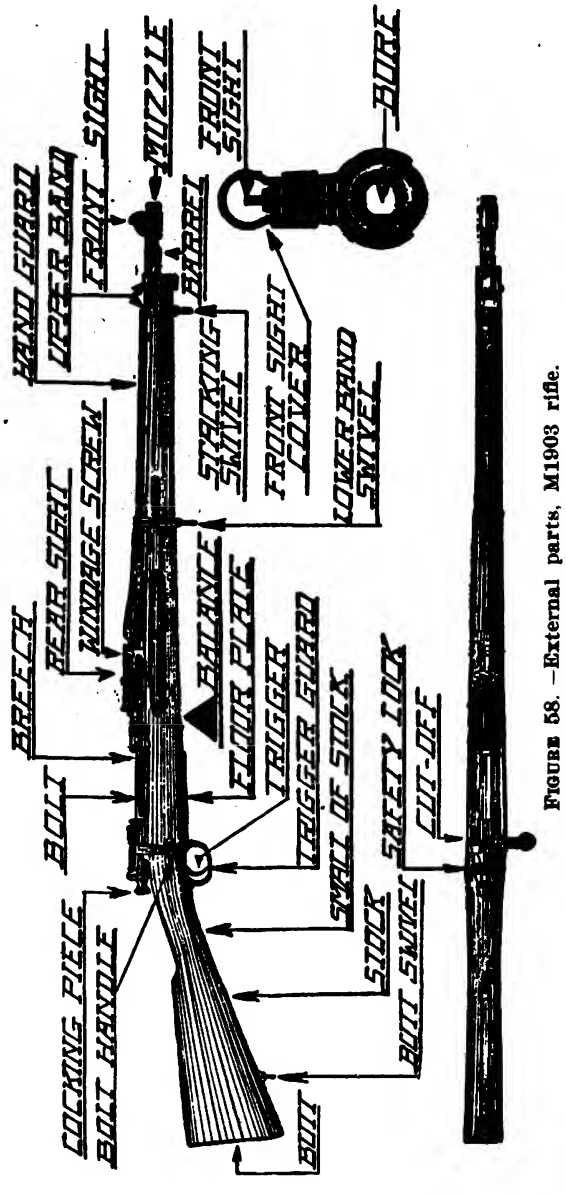


FIGURE 58.—External parts, M1903 rifle.

Q. Describe the normal peep sight. *A*. The top of the front sight appears to be in the center of the peep.

Q. What is battle sight, and what range is battle sight? *A*. The sight when the sight leaf is *down*—range about 547 yards. The sights are alined as for the normal open sight.

Q. In firing with battle sight, how high is the trajectory above the line of sight at 300 yards? *A.* 2½ feet.

Q. What preparatory instructions should be held before going on the range? *A.* The six steps of preparatory instructions are—

(1) Sighting and aiming exercises (with sighting bar and rest).

(2) Position exercises.

(3) Trigger squeeze exercise.

(4) Rapid fire exercises, in all positions.

(5) Instruction in the effect of wind, sight changes, and use of score book.

(6) Examination before going on the range.

Q. What do you mean by the "zero" of a rifle? *A.* The point at which the rear sight must be set for both elevation and windage for any particular range in order to hit the center of the bull's-eye on a normal day when there is no wind.

Q. What do you mean by "cant" and what is its effect? *A.* It is tilting the rifle to the right or left. The effect is to cause the rifle to shoot low and to the side the rifle is tilted.

Q. Where do you focus your eye when aiming a rifle? *A.* On the target.

Q. In firing at a vertical target what is the rule for correcting your fire in elevation? *A.* Square the range expressed in hundreds of yards. The result is the number of inches on the target that the next shot will strike above (or below) if the rear sight is raised or lowered 100 yards. Example: When firing at the 200-yard range, raising the rear sight 100 yards will move the next shot 4 inches up on the target.

Q. To shoot to the right (or left), which way would you move the sight? *A.* To shoot to the right move the movable base of the sight to the right. To shoot to the left move the movable base of the sight to the left.

Q. How much does one point on the windage scale correct for? *A.* Four inches for every 100 yards of range; so at 300 yards range one point corrects for about 12 inches.

Q. How do you figure the effect of a cross wind? *A.* Multiply the range in hundreds of yards by velocity of the wind divided by 10 to find the number of quarter points correction necessary. Example: When firing at the 200-yard range, a 10-mile wind calls for ½ point correction.

Q. What is the smallest graduation on the windage scale? *A.* A point—*not* a quarter point.

Q. In what direction do you move the sight to correct for wind effect? *A.* Always into the wind.

Q. How do you aim when using guard ammunition? *A.* Use battle sight and aim at the hips.

Q. What are the positions for rifle firing? *A.* Standing, kneeling, sitting, and prone.

Q. Describe and demonstrate the firing positions. *A.* For all positions face half right from direction of fire and then take the position. The rifle then makes an angle of 45° with the body and should point

FIGURE 59.—Standing position, showing hasty sling adjustment.

easily and naturally at the target. The right hand grasps the small of the stock, thumb either around or along the stock; the left hand is near the lower band swivel, piece resting on the palm and in the crotch between thumb and fingers, left elbow as nearly directly under the rifle as possible. The neck and jaw are pressed firmly against the stock. The trigger is squeezed with the first or second joint of the right forefinger. Standing position—feet 12 to 24 inches apart. Kneeling position—the left lower leg is vertical, point of left elbow just over point of knee, the firer sitting on right heel or side of right foot. Sitting position—feet 12 to 24 inches apart and dug into ground, upper arms braced against insides of knees. Prone position—legs straight and well apart, insides of feet flat on ground (or nearly so), shoulders raised on elbows. (See figs. 59 to 62, incl.)

Q. What is the purpose of the sling? *A.* It is used to carry the rifle on long marches, and to afford a steady position and thus improve aim in firing.

FIGURE 60.—Kneeling position, showing loop sling adjustment.

FIGURE 61.—Sitting position.

Q. How is the sling used in firing? *A.* There are two adjustments called the hasty sling and the loop adjustment. (See figs. 59 and 60.)

Q. What is the most important thing in successful rifle shooting? *A.* Correct trigger squeeze.

Q. Explain how to squeeze the trigger correctly? *A.* The trigger should never be jerked as this always spoils the aim. The rifleman alines his sights accurately on the bull's-eye, and when he has them alined he slowly squeezes the trigger. If the sights wander off the bull's-eye he stops squeezing the trigger, but holds what he has taken up. He brings his sights back into alinement and then continues to squeeze the trigger. The trigger is squeezed only when the sights are on the bull's-eye. After two or possibly three squeezings the rifle goes off with the sights properly alined. This procedure is the secret of successful rifle shooting.

Q. What mechanisms is the soldier permitted to disassemble? *A.* The bolt and magazine mechanisms only.

Q. Describe how to disassemble and assemble the bolt mechanism. *A.*

FIGURE 62.—Prone position.

(1) *To disassemble bolt mechanism.*—(*a*) Place cut-off at the center notch.

(*b*) Cock piece and turn safety lock to a vertical position.

(*c*) Raise bolt handle and draw out bolt.

(*d*) Hold bolt in left hand, press sleeve lock in with thumb of right hand to unlock sleeve from bolt, and unscrew sleeve by turning to the left.

(*e*) Hold sleeve between forefinger and thumb of the left hand, draw cocking piece back with middle finger and thumb of right hand, turn safety lock down to the left with the forefinger of the right hand and allow the cocking piece to move forward in sleeve, thus partially relieving the tension of mainspring.

(*f*) With the cocking piece against the breast, draw back firing pin sleeve with the forefinger and thumb of right hand, and hold it in this position while removing the striker with the left hand.

(*g*) Remove firing pin sleeve and mainspring.

(*h*) Pull firing pin out of sleeve.

(*i*) Turn extractor to the right, forcing its tongue out of its groove in the front of the bolt, and force the extractor forward and off the bolt.

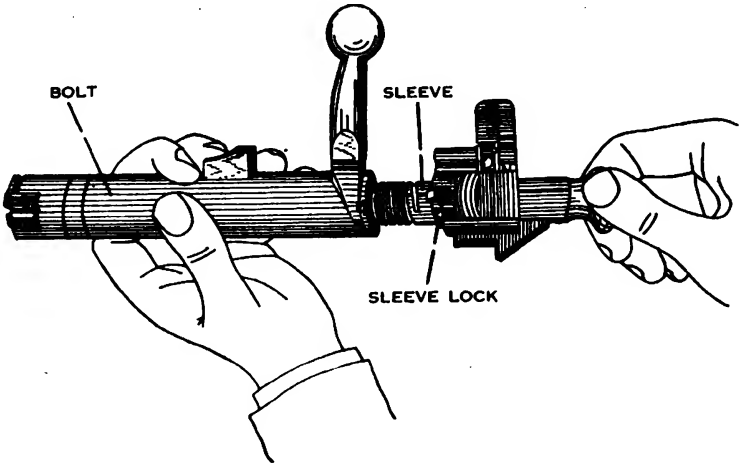


FIGURE 63.—Disassembling bolt mechanism.

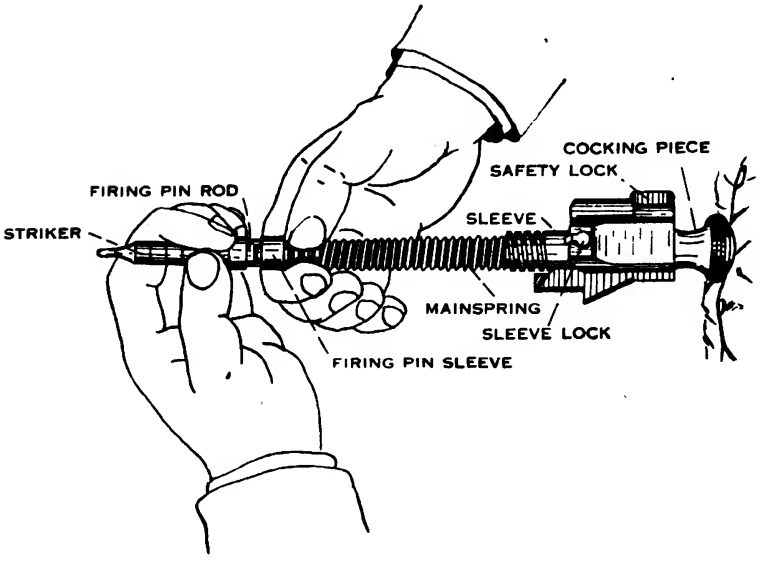


FIGURE 64.—Firing pin.

(2) *To assemble bolt mechanism.*—(*a*) Grasp with the left hand the rear of the bolt, handle up, and then turn extractor collar with the thumb and forefinger of the right hand until its lug is on a line with the safety lug on the bolt.

(*b*) Take extractor in the right hand and insert lug on the collar in the undercuts in the extractor by pushing the extractor to the rear

until its tongue comes in contact with the rim on the face of the bolt (a slight pressure with the left thumb on the top of the rear part of the extractor assists in this operation).

(*c*) Turn extractor to the right until it is over the right lug.

(*d*) Take bolt in the right hand and press hook of the extractor against the butt plate or some rigid object until the tongue on the extractor enters its groove in the bolt.

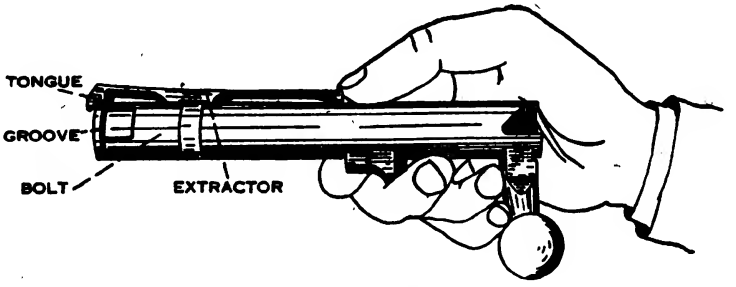


FIGURE 65.—Bolt.

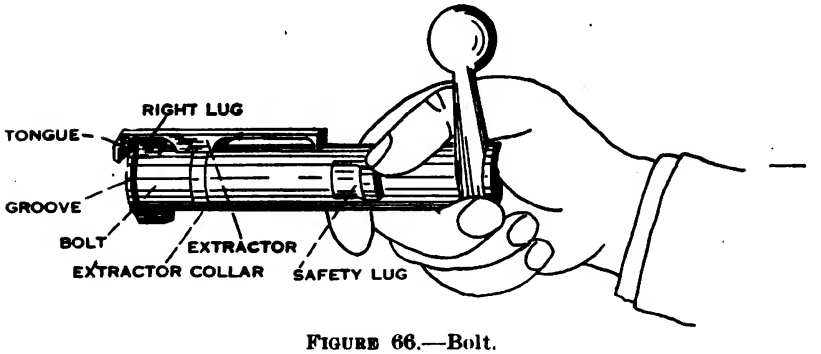


FIGURE 66.—Bolt.

(*e*) With the safety lock turned down to the left to permit the firing pin to enter the sleeve as far as possible, assemble sleeve and firing pin.

(*f*) Place cocking piece against the breast and put on main spring, firing pin sleeve, and striker.

(*g*) Hold cocking piece between the thumb and the forefinger of the left hand, and by pressing the striker point against some substance, not hard enough to injure it, force cocking piece back until the safety lock can be turned to the vertical position with the right hand.

(*h*) Insert firing pin in the bolt and screw up sleeve (by turning it to the right) until the sleeve lock enters its notch on the bolt.

(*i*) See that cut-off is at the center notch; hold piece under floor plate in the fingers of the left hand, the thumb extending over the left side of the receiver; take bolt in right hand with safety lock in a

vertical position and safety lug up; press rear end of follower down with left thumb and push bolt into the receiver.

(*j*) Lower bolt handle, turn safety lock and cut-off down to the left with right hand.

Q. Describe how to disassemble and assemble the magazine mechanism. *A*.

(1) *To disassemble magazine mechanism.*—With the bullet end of a cartridge press on floor plate catch (through the hole in the floor plate), at the same time drawing the bullet to the rear; this releases the floor plate. Raise rear end of the first limb of the magazine spring high enough to clear the lug on the floor plate and draw it out of its mortise; proceed in the same manner to remove the follower.

(2) *To assemble magazine spring and follower to floor plate.*—Reverse operation of disassembling. Insert follower and magazine spring in the magazine, place tenon on the front end of the floor plate in its recess in the magazine, then place lug on the rear end of the floor plate in its slot in the guard, and press rear end of the floor plate forward and inward at the same time, forcing the floor plate into its seat in the guard.

b. Maintenance of rifle.—*Q*. What causes the most damage to a rifle when it is not properly cared for? *A*. Water and perspiration. If allowed to remain on the metal parts of a rifle it will form rust and the surface of the metal will become "pitted."

Q. How is a rifle protected from water and perspiration? *A*. By removing all moisture from the metal parts and covering them with a coating of oil or grease.

Q. Why should a rifle be cleaned after daily drill? *A*. Because handling the weapon removes oil and allows moisture from the hands to get on it.

Q. How do you clean a rifle after daily drill? *A*.

(1) Rub the outside, including the stock and sling, with a rag that has been slightly oiled, and then clean it with a perfectly dry rag. Swab bore with an oily flannel patch and then with two or three perfectly dry ones. Dust out all screw heads and crevices with a small clean brush.

(2) Immediately after cleaning, swab bore with a flannel patch saturated with oil (or grease), finally drawing the patch smoothly through the bore and out of the chamber, allowing the cleaning rod to turn with the rifling. Wipe over all metal parts, including the bolt mechanism and magazine, with an oily rag and put a few drops of sperm oil on all cams and working surfaces. Put a teaspoonful of linseed oil in the palm of the hand and polish the stock.

Q. Should a rifle be covered when stored in the gun rack? *A.* No. Canvas covers collect moisture which causes the rifle to rust underneath the cover. *The use of rifle covers is prohibited.* (Gun racks will be covered temporarily when barracks are being swept.)

Q. Should a rifle be stored in a gun rack (or any other place) without a protective coating of oil? *A.* No. Even a perfectly clean and dry weapon will soon collect moisture which will damage the metal parts unless they are protected with oil or grease.

Q. How is the sling cleaned? *A.* First wash with a sponge well lathered with castile soap. When partially dry, apply a lather of saddle soap. When this is nearly dry, rub with a dry cloth until the sling is polished. Dry the sling in a cool place. Never dry leather in the sun.

Q. What tool should be used to swab the bore of a rifle? *A.* A barracks cleaning rod should always be used. The thong and brush may be used only if the barracks cleaning rod is not available.

Q. From what end of the rifle should the bore be swabbed? *A.* From the breech, removing the bolt to allow cleaning. Never swab the bore from the muzzle end because of possible damage to the muzzle.

Q. What parts of a rifle should be removed for cleaning? *A.* Front sight cover; floor plate and follower; gun sling; oiler and thong case; and the bolt, which may also be taken apart.

Q. What tool may be used for tightening or loosening screws? *A.* Only a properly fitting screw driver. Never use a bayonet or other substitute because it will damage the screw heads.

Q. Should a rifle be cleaned before firing? *A.* Yes. Always wipe out the bore with a clean patch before going to the firing point. See that no dust, dirt, mud, snow, rags, patches, or other obstructions are in the bore before firing.

Q. What are the three main forms of the residue left in the bore after a rifle is fired? *A.*

(1) A coating of chemicals left by the burned powder and primer.

(2) Particles of unburned or partially burned powder, called powder fouling.

(3) Particles of metal from the jacket of the bullet, called metal fouling.

Q. How does this residue damage a rifle if not removed? *A.* The chemicals attract moisture from the air which collects in the bore. The powder fouling and the metal fouling trap moisture underneath, against the bore. The moisture causes rusting and pitting of the bore.

Q. How is a rifle cleaned after firing? *A.* The chemicals and powder fouling are dissolved by scrubbing the bore with a dissolving solution of hot water and issue soap or a sal soda solution. Hot water alone may also be used. (Cold water is used only when none of the other agents is available.)

(1) Remove the bolt and place the muzzle in a vessel containing the dissolving solution. Using a cleaning rod and a flannel patch inserted from the breech, pump the solution back and forth through the bore for about 1 minute.

(2) Next place a brass or bronze wire brush on the rod and run it through the bore all the way down and back three or four times, leaving the muzzle in the dissolving solution. A wire brush is necessary to remove the powder fouling thoroughly.

(3) Next remove the brush from the rod and swab several more times with the dissolving solution.

(4) Then wipe the cleaning rod dry, remove the muzzle from the solution and, using dry, clean flannel patches, thoroughly swab the bore until it is perfectly dry and clean. Also dry off the chamber and other metal parts thoroughly.

(5) Finally, inspect the bore for metal fouling. If no metal fouling is present prepare the weapon for storage as you do after daily cleaning and place it in the gun rack. The bore must similarly be cleaned and regreased each day for the next succeeding 3 days to insure that no trace of fouling remains.

Q. How do you inspect the bore for metal fouling? *A.* Hold the butt of the rifle pointed toward the sky and examine the bore from the muzzle, with the eye about 8 inches from the muzzle. If small smears, flakes, or lumps looking like dull lead are seen on the surface of the bore. this is metal fouling. It usually occurs within about 6 inches from the muzzle.

Q. What do you do in case you find metal fouling? *A.* Take the rifle to the supply sergeant and ask for instructions.

Q. How is metal fouling removed? *A.* It is removed with metal fouling solution which must be used only by qualified ordnance personnel.

Q. How soon after firing should a rifle be cleaned? *A.* As soon as possible after firing. A weapon should never be put away for the night without being cleaned.

Q. What oils can be used on rifles? *A.*

(1) For metallic surfaces, sperm oil for lubrication and medium rust-preventive compound for protection from rusting. No other oils should be used unless authorized by the battery commander or his representative.

(2) For the stock, raw linseed oil. When in the field the stock may be wiped off occasionally with a cloth moistened with sperm oil.

Q. State some of the things one is prohibited from doing with a rifle? *A.*

(1) Except for the removal of those parts permitted for cleaning, a rifle will not be disassembled except by permission of a commissioned officer, and then only under the supervision of a qualified person who knows the provisions contained in the ordnance pamphlet on the subject.

(2) Blued or browned parts of rifles must not be polished.

(3) All mutilations such as carving are prohibited.

(4) Nothing except the authorized oils may be used on a rifle.

(5) Weapons must be unloaded before being taken into barracks or tents.

c. Ammunition.—Q. What are the parts of a ball cartridge? *A.* Cartridge case, primer, powder, bullet.

Q. What is the purpose of the primer? *A.* To ignite the smokeless powder.

Q. Describe the bullet for ball cartridge. *A.* It has a core of lead and tin composition inclosed in a jacket of gilding metal, covered with a tin wash. The point is very sharp so as to offer little resistance to the air.

Q. Describe the dummy cartridge. *A.* The bullet is similar to the bullet for the ball cartridge. To distinguish it from the ball cartridge, the dummy cartridge has a tinned case provided with six long straight grooves along it and three holes through it.

Q. Describe the guard cartridge. *A.* The guard cartridge is distinguished from the ball cartridge by having either 5 grooves around the case (old style) or 6 short grooves at the shoulder (new style).

Q. What other type of ammunition may be used for guard purposes? *A.* Where the supply of guard cartridges has been exhausted, the gallery practice cartridge M1919 may be issued for guard purposes.

Q. What is the weight of the ball cartridge? *A.* About an ounce; 100 rounds weigh about 5½ pounds.

Q. How is ammunition packed? *A.* In wooden chests (metal lined) containing 1,200 rounds; in cloth bandoleers holding 60 rounds, and metal clips of 5 rounds each.

Q. What types of service ammunition are used with the M1903 rifle? *A.* Ball M2 and M1906; tracer M1; and armor-piercing M1.

Q. What distinguishes armor-piercing and tracer ammunition from ball ammunition? *A.* Armor-piercing is painted black for

¼ inch from the point. Tracer is painted red for ¼ inch from the point.

Q. At what distance is it dangerous to fire at personnel, representing an enemy, with rifles loaded with blank ammunition? *A.* Never fire at personnel representing an enemy at distances less than twenty yards.

Q. What is the standard type of ball ammunition? *A.* Ball cartridge, caliber .30, M2, is standard.

52. Rifle, U. S., caliber .30, M1.—*a. Nomenclature and action.*—*Q.* Briefly describe the U. S. rifle, caliber .30, M1. *A.* The U. S. rifle, caliber .30, M1, is a gas operated, clip fed, self-loading, shoulder weapon. The gas generated in a cartridge fired in the rifle is utilized to compress the operating rod spring and compensating spring to extract and eject the fired case and to cock the hammer. The operating rod spring and compensating spring, which are meantime forcing the cartridges up in the clip, complete the cycle by closing and locking the bolt. The bolt as it goes forward strips the top cartridge from the clip and chambers it. The rifle is then ready to fire.

Q. What is meant by caliber .30? *A.* Caliber .30 means that the distance between two directly opposite lands in the barrel, expressed in inches, is 30/100 of an inch.

Q. What are the lands and grooves? *A.* The lands are the raised portions of the bore and the grooves are the spaces between the lands.

Q. What direction of twist do the lands and grooves in the bore give the bullet? *A.* A right twist, or clockwise as seen from the breech.

Q. How does this affect the bullet? *A.* The rotation keeps the bullet from tumbling in flight, but also causes it to drift slightly to the right.

Q. In firing, should any allowance be made for drift? *A.* No. This is automatically corrected for in the construction of the rear sight.

Q. How many cartridges may be loaded in this rifle at one time? *A.* Eight cartridges are loaded in a reversible clip.

Q. What limits the rate of fire? *A.* The rate of fire is limited only by the proficiency of the soldier in marksmanship, and his dexterity in inserting clips into a magazine.

Q. What is the weight of this rifle? *A.* The weight of the rifle is approximately 9 pounds and the bayonet an additional pound, while the weight of a loaded clip of cartridges (8 cartridges M1) is slightly in excess of 0.5 pound.

Q. What is the maximum range graduation on the rear sight? *A*. 1,200 yards.

Q. What is the muzzle velocity of the ball cartridge? *A*. 2,700 feet per second.

Q. What is the muzzle velocity of the guard cartridge? *A*. 1,200 feet per second.

Q. Point out the following parts:

Butt plate.
Rear sight base.
Rear sight elevating knob screw.
Rear sight elevating knob.
Clip latch.
Bolt.
Rear hand guard band.
Rear hand guard.
Lower band.
Front hand guard.
Front sight.
Gas cylinder plug.
Gas cylinder plug screw.
Barrel.
Extractor.
Operating rod.
Rear sight cover.
Aperture.
Stock.
Comb.
Heel.
Toe.
Rear sight nut.
Rear sight windage knob.
Receiver.
Front hand guard ferrule.
Front sight screw.
Gas cylinder.
Stacking swivel.
Stacking swivel screw.
Stock ferrule.
Stock ferrule screw.
Stock ferrule swivel.
Gun sling keeper.
Gun sling hook.
Gun sling long strap.
Gun sling.
Safety.
Trigger.
Trigger guard.
Gun sling loop.
Gun sling short strap.
Butt swivel.

A. See figure 67.

Q. How is the ammunition loaded into the cartridge clip? *A*. A clip loading machine (no more to be issued) is sometimes used to load ammunition into clips. In loading the cartridge clip by hand care must be taken to see that the base of each cartridge is close to the rear wall of the clip so that the inner rib of the clip engages the extractor groove in the cartridge, and that each clip is fully loaded with eight cartridges. For ease in inserting the clip it is preferable to have the uppermost cartridge on the right side of the clip.

Q. How is the clip loaded into the rifle? *A*. The operation of loading is performed with the piece locked, that is, with the safety

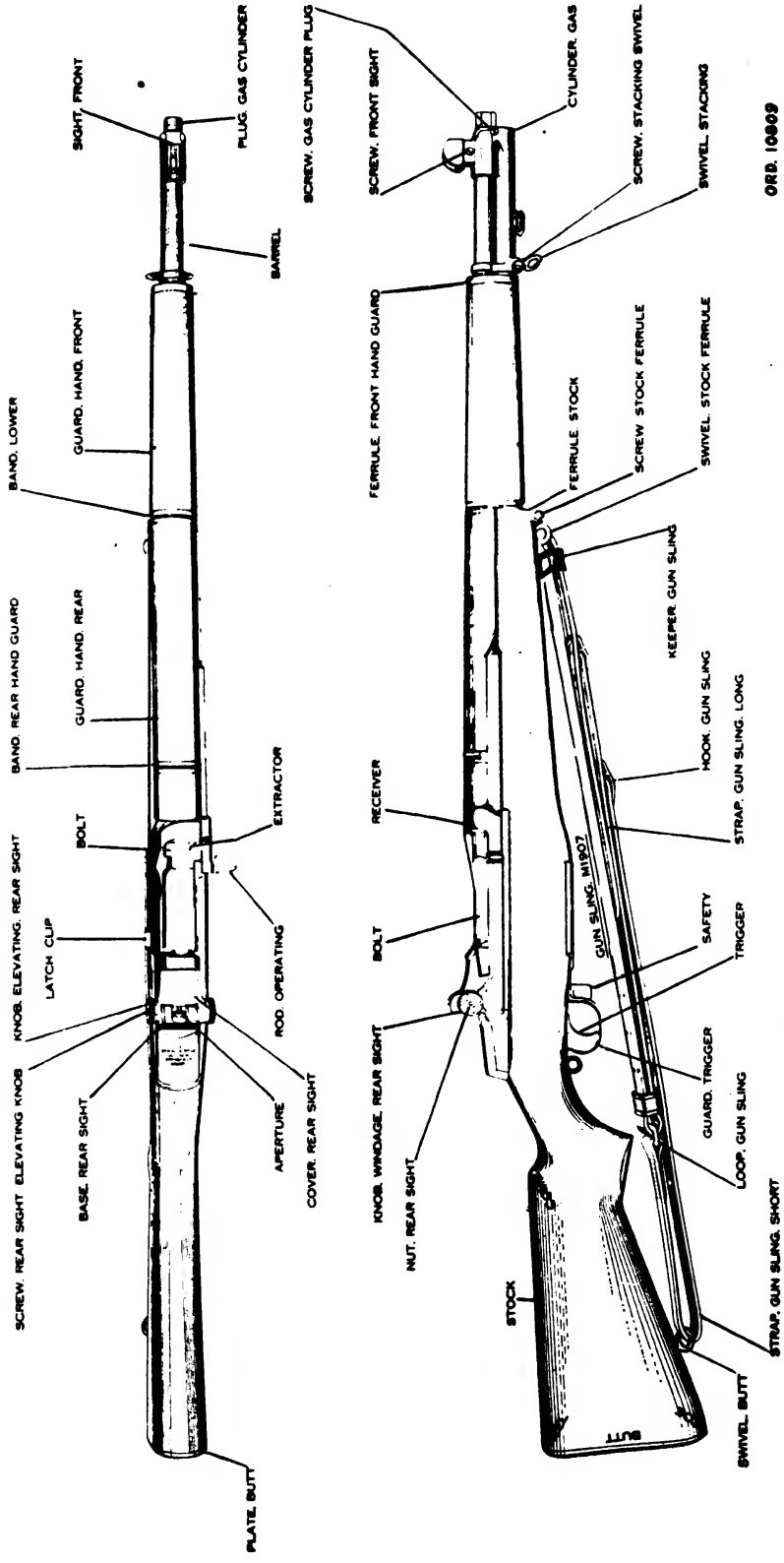


FIGURE 67.—U. S. rifle, caliber .30, M1, top and right side views.

of the piece in its rearmost position, except in sustained firing. Hold rifle at the balance in the left hand. With the forefinger of the right hand, pull operating rod handle smartly to the rear until the operating rod is caught by the operating rod catch. With the right hand take a fully-loaded clip and place it on top of the follower. Place right side of the right hand against the operating rod handle and with the thumb of the right hand press clip down into the receiver until it engages the clip latch. Swing thumb to the right so as to clear the bolt in its forward movement and release operating rod handle. The closing of the bolt may be assisted by a push forward on the operating rod handle with the heel of the right hand.

Q. How is the rifle fired? *A.* The trigger must be squeezed for each shot. After the eighth shot has been fired, the empty clip is automatically ejected upward out of the receiver to the right and the bolt remains open ready for the insertion of another clip. Should the gun be permitted to recoil in such a manner as to cause the trigger to be released and then by a rebound of the shoulder force the gun forward, causing the trigger to strike the trigger finger and be pulled a second time, the firing of a second round may result. *Caution should be exercised against this.*

Q. Can the hammer be cocked without unlocking the bolt? *A.* Yes. In case of misfire or other occasion when it is desired to cock the hammer without unlocking the bolt, unlatch the trigger guard and swing it to its extreme downward position. (See fig. 68.) Close and latch the trigger guard and the rifle is ready to be fired.

Q. How is the rifle set at safe? *A.* The rifle being loaded, if it is not desired to fire at once, is set at safe by pulling to the rear on the front surface of the safety until it occupies its rearmost position inside the trigger guard. In this position the trigger cannot be pulled. The rifle may be loaded and operated by hand when the safety is on but it cannot be fired. It can only be set at safe when the hammer is cocked. To set the rifle at ready, push safety to its extreme forward position.

Q. How is a loaded clip removed from the magazine without firing the rifle? *A.* To remove a loaded cartridge clip from the magazine of the rifle without firing, hook the right forefinger over the operating rod handle, pull and hold in the extreme rear position, with the left hand over the magazine, using the left thumb to release the clip latch. The clip with contained cartridges will then be ejected upward out of the magazine into the hand. Do *not* allow the bolt to move forward after pulling it to the rear, as the top cartridge will be moved forward out of its position in the clip, and will prevent the normal ejection.

Q. How is the rifle unloaded? *A.* Pull operating rod handle to rearmost position, thus extracting and ejecting cartridge from the chamber. Hold the operating rod full to the rear and proceed as when removing a loaded clip from the magazine. If it is desired to close the bolt on an empty chamber and retain a partially loaded clip in the magazine, press down on the top cartridge in the clip allowing the bolt to slide forward, being sure that it is fully closed. *This procedure is exceptional as the rifle is normally either loaded or "clear."*

FIGURE 68.—Cocking the hammer without unlocking the bolt.

Q. Describe the adjustment of the rear sight. *A.* The rear sight is adjusted vertically by turning the elevating knob, which is on the left side and has numbered graduations for 200, 400, 600, 800, 1,000, and 1,200 yards range. Index lines between the numbered lines correspond to 100, 300, 500, 700, 900, and 1,100 yards range. Adjustment for windage is made by windage knob on the right, each windage graduation representing four minutes of angle. The elevating and windage knobs are provided with "clicks" which represent approximately one minute of angle or one inch at one hundred yards. Arrows on knobs indicate direction of rotation for desired changes in point of impact. The rotation of the elevating knob may be eased by forcing the knob outward, away from receiver, while turning.

Q. What safety precautions must be taken with the M1 rifle? *A.* While any cartridges remain in the magazine after a round has been fired, the rifle is ready to fire, and the gun is safe only when it is

"cleared." In other words, the gun is never *known* to be safe when the bolt is closed. To clear the gun, pull operating rod fully to the rear, extracting and ejecting cartridge from the chamber, and remove the clip from the magazine *leaving the bolt open.* When the rifle is hot from repeated firing, *a cartridge must not be left in the chamber.* When for any reason firing is suspended for any considerable time, *clear the gun.* Overheated cartridges produce abnormal pressures, are liable to preignition, and increase extraction effort to such an extent that the rim of the cartridge case is likely to be pulled off leaving the case in the chamber.

Q. What preparatory instructions should be held before going on the range? *A.* The six steps of preparatory instructions are—

(1) Sighting and aiming exercises (with sighting bar at rest).

(2) Position exercises.

(3) Trigger squeeze exercise.

(4) Rapid fire exercises, in all positions.

(5) Instruction in the effect of wind, sight changes, and use of score book.

(6) Examination before going on the range.

Q. What do you mean by the "zero" of a rifle? *A.* The point at which the rear sight must be set for both elevation and windage for a particular range, in order to hit the center of the bull's-eye on a normal day when there is no wind.

Q. What do you mean by "cant" and what is its effect? *A.* It is tilting the rifle to the right or left. The effect is to cause the rifle to shoot low and to the side the rifle is tilted.

Q. Where do you focus your eye when aiming a rifle? *A.* On the target.

Q. What are the positions for rifle firing? *A.* Standing, kneeling, sitting, and prone.

Q. Describe and demonstrate the firing positions. *A.* For all positions, face half right from direction of fire and then take the position. The rifle then makes an angle of 45° with the body and should point easily and naturally at the target. The right hand grasps the small of the stock, thumb either around or along the stock; the left hand is near the lower band swivel, piece resting on the palm and in the crotch between thumb and fingers, left elbow as nearly directly under the rifle as possible. The neck and jaw are pressed firmly against the stock. The trigger is squeezed with the first or second joint of the right forefinger. Standing position—feet 12 to 24 inches apart. Kneeling position—the left lower leg is vertical, point of left elbow just over point of knee, the firer sitting on right heel or side of right

foot. Sitting position—feet 12 to 24 inches apart and dug into the ground, upper arms against insides of knees. Prone position—legs straight and well apart, insides of feet flat on ground (or nearly so), shoulders raised on elbows. (See figs. 59, 60, 61, and 62.)

Q. What is the purpose of the sling? *A.* It is used to carry the rifle on long marches, and to afford a steady position and thus improve aim in firing.

Q. How is the sling used in firing? *A.* There are two adjustments, called the hasty sling and the loop adjustment. (See figs. 59 and 60.)

Q. What is the most important thing in successful rifle shooting? *A.* Correct trigger squeeze.

Q. Explain how to squeeze the trigger correctly. *A.* The trigger should never be jerked as this always spoils the aim. The rifleman alines his sights accurately on the bull's-eye, and when he has them alined he slowly squeezes the trigger. If the sights wander off the bull's-eye he stops squeezing the trigger, but holds what he has taken up. He brings his sights back into alinement and then continues to squeeze the trigger. The trigger is squeezed only when the sights are on the bull's-eye. After two, or possibly three squeezings the rifle goes off with the sights properly alined. This procedure is the secret of successful rifle shooting.

b. Maintenance of rifle.—Q. What causes the most damage to a rifle when it is not properly cared for? *A.* Water and perspiration. If allowed to remain on the metal parts of a rifle it will form rust and the surface of the metal will become "pitted."

Q. How is a rifle protected from water and perspiration? *A.* By removing all moisture from the metal parts and covering them with a coating of oil or grease.

Q. Should a rifle be covered when stored in a gun rack? *A.* No. Canvas covers collect moisture which causes the rifle to rust underneath the cover. *The use of rifle covers is prohibited.* (Gun racks will be covered temporarily when barracks are being swept.)

Q. Should a rifle be stored in a gun rack (or any other place) without a protective oil coating? *A.* No. Even a perfectly clean and dry weapon will soon collect moisture which will damage the metal parts unless they are protected with oil or grease.

Q. How is the sling cleaned? *A.* First wash with a sponge well lathered with castile soap. When partially dry, apply a lather of saddle soap. When this is nearly dry, rub with a dry cloth until the sling is polished. Dry the sling in a cool place. Never dry leather in the sun.

Q. Why should a rifle be cleaned after daily drill? *A.* Because handling the weapon removes oil and allows moisture from the hands to get on it.

Q. What tool should be used to swab the bore of a rifle? *A.* A barracks cleaning rod should always be used. The thong and brush may be used only if the barracks cleaning rod is not available.

Q. What tool may be used for tightening or loosening screws? *A.* Only a properly fitting screw driver. Never use a bayonet or other substitute because it will damage the screw heads.

Q. Describe the care and cleaning of the M1 rifle in garrison and camp. *A.* Rifles should be disassembled only to the extent necessary to insure proper condition and cleanliness. The bore of the rifle is always cleaned with a cleaning rod, from the muzzle. If the length of the cleaning rod is such that contact can be made with the face of the retracted bolt, *the bolt must be protected.* To clean the bore push a lightly oiled patch through it and out the breech end. This should be followed with dry patches until several successive ones come out absolutely clean. Push through the bore a patch saturated with oil, to protect its surface. If local climatic conditions necessitate, bores and chambers may be coated with standard rust preventive compound. To clean screw heads and crevices use a small cleaning brush or small stick. To clean metal surfaces wipe with a dry cloth to remove moisture, perspiration, and dirt. Then wipe with a lightly oiled cloth using aircraft instrument and machine-gun lubricating oil. This protective film must be maintained *at all times.* To clean the outer surface of the rifle, including the stock, hand guards, and sling, wipe off dirt with a lightly oiled cloth, and clean with soft dry one. In cleaning the bore, care must be taken not to foul the cleaning patch in the gas port. Repeat until several successive patches come out absolutely clean. Saturate a patch in sperm oil and push it through the bore, holding the rifle, top up, so that some sperm oil will flow into the gas port.

Q. Describe the care and cleaning of the M1 rifle preparatory to firing. *A.* This differs from the procedure described in the care and cleaning of the M1 rifle in garrison and camp in that Dixon's graphite cup grease No. 3 is substituted for aircraft machine-gun lubricating oil on many of the moving parts of the weapon. The rifle is disassembled and the bore is cleaned and oiled very lightly. (*The chamber is not oiled.*) Any carbon which may have formed on the gas cylinder plug and the piston head is removed. After thoroughly cleaning and lightly oiling all metal parts, a thin uniform coating of the graphite cup grease, referred to above, is applied to the following parts: Bolt

lugs including locking and operating, bolt guides, cocking cam on bolt, compensating spring, contact surfaces of barrel and operating rod, cam, operating rod guide groove in receiver and the operating rod spring. *The graphite cup grease should under no circumstances be applied to the follower slide or the under surface of the bolt, as the introduction of graphite into the chamber may lead to the generation of excessive pressure.* After the rifle has been assembled all outer surfaces should be rubbed lightly with an oiled rag.

Q. What are the three main forms of residue left in the bore after a rifle is fired? *A.*

(1) A coating of chemicals left by the burned powder and primer.

(2) Particles of unburned or partially burned powder called *powder fouling.*

(3) Particles of metal from the jacket of the bullet called *metal fouling.*

Q. How does this residue damage a rifle if not removed? *A.* The chemicals attract moisture from the air which collects in tbe bore. The powder fouling and metal fouling trap moisture underneath, against the bore. The moisture causes rusting and pitting of the bore.

Q. How do you inspect the bore for metal fouling? *A.* Hold the butt of the rifle pointed toward the sky and examine the bore from the muzzle, with the eye about 8 inches from the muzzle. If small smears, flakes, or lumps looking like dull lead are seen on the surface of the bore, this is metal fouling. It usually occurs within about 6 inches from the muzzle.

Q. Describe the care and cleaning of the M1 rifle after firing. *A.* The bore of the rifle must be thoroughly cleaned by evening of the day on which it is fired, and similarly cleaned for the next three days. Under no circumstances is the use of any metal fouling solution in the rifle permitted. After disassembling the rifle, the barrel and receiver assembly, *with the bolt removed*, should be supported at an angle of about 45° with the barrel down. *The bore is always cleaned from the muzzle.* A flannel patch saturated with water is pushed through the bore and out the breech end. This is repeated with several patches followed with dry patches until they come out clean and dry. Then one patch saturated with oil is pushed through the bore and two patches inserted in the slot in the chamber cleaning tool, wrapped smoothly about it, and the chamber scrubbed by twisting the tool. If the rifle is not to be fired the following day, proceed as in care and cleaning in *garrison and camp.* However, if the rifle is to be used the next day, the procedure described in care and cleaning of the M1 rifle preparatory to firing should be followed. If the rifle

is not to be fired for a considerable period, or if local conditions cause excessive formation of rust, a rust preventive should be applied to the bore and chamber after cleaning; for storage all metal parts should be protected in the same manner. Heavy oil and grease must be removed from the bore and chamber before firing.

TABLE OF STOPPAGES

Malfunction	Cause	Correction by soldier
Clip jumps out on seventh round.	Bent follower rod	Replace.
Failure to extract	(1) Dirty or rough chamber.	(1) Clean chamber.
	(2) Restricted gas port.	(2) Clean gas port.
Failure to feed	(1) Dirty or rough chamber.	(1) Clean chamber.
	(2) Restricted gas port.	(2) Clean gas port.
	(3) Dirty rifle or improper lubrication.	(3) Clean rifle and lubricate.
	(4) Bent clip	(4) Replace clip.
	(5) Ruptured cartridge case in chamber.	(5) Remove ruptured cartridge case.
Fires automatically	Sear broken or remains in open position.	Replace trigger assembly or hammer spring housing.
Safety releases when pressure is applied on trigger.	Round heel on safety, or broken safety.	Replace safety.
Pull on trigger does not release hammer.	(1) Deformed hammer or trigger or worn trigger pin.	(1) Replace defective part.
	(2) Trigger strikes trigger housing.	(2) Turn in to ordnance.
Hammer releases but gun does not fire.	(1) Bolt not all the way seated.	(1) Clean and lubricate.
	(2) Defective ammunition.	(2) Discard round.
	(3) Broken firing pin	(3) Replaced.
Rear sight elevation jumps.	Lose rear sight nut	Tighten.
Creep in trigger	Burs on trigger or hammer lugs.	Turn in to ordnance.

Q. Describe the care and cleaning of the M1 rifle on the range. *A*. The rifle must never be fired with any dirt, mud, or snow in the bore, and the chamber should be kept free and clean from any oil or dirt.

A patch plug or other obstruction must never be allowed to remain in the chamber or bore and neglect of this precaution may result in serious injury.

Q. Describe the care and cleaning of the rifle in the field. *A.* The rifle must be kept clean and free from dirt, and properly lubricated with graphite cup grease. To obtain maximum efficiency the chamber must be kept clean; additional graphite cup grease is applied to the parts, as prescribed in care and cleaning *preparatory to firing*, at the first opportunity after indications of excessive friction occur; a light coating of oil is kept on all other metal parts; and carbon is removed from the gas cylinder plug and piston head. In general, it should not be necessary to remove any parts of the rifle in the field except the trigger housing group and the gas cylinder plug.

Q. State some of the things one is prohibited from doing with a rifle. *A.*

(1) Except for the removal of those parts permitted for cleaning, a rifle will not be disassembled except by permission of a commissioned officer, and then only under the supervision of a qualified person who knows the provisions contained in the ordnance pamphlet on the subject.

(2) Blued or browned parts of rifle must not be polished.

(3) All mutilations such as carving are prohibited.

(4) Nothing except the authorized oils may be used on a rifle.

(5) Weapons must be unloaded before being taken into barracks or tents.

c. Ammunition.—*Q.* What are the parts of the ball cartridge? *A.* Cartridge case, primer, powder, bullet.

Q. What is the purpose of the primer? *A.* To ignite the smokeless powder.

Q. Describe the bullet for ball cartridge. *A.* It has a core of lead and tin composition inclosed in a jacket of cupro-nickel. The point is very sharp so as to offer little resistance to the air.

Q. Describe the bullet for the dummy cartridge. *A.* The bullet is similar to the bullet for the ball cartridge. To distinguish it from the ball cartridge, the dummy cartridge has a tinned case provided with six long straight grooves along it and three holes through it.

Q. Describe the guard cartridge. *A.* The guard cartridge is distinguished from the ball cartridge by having 5 grooves around the case (old style) or six short straight grooves at the shoulder (new style).

Q. What other type of ammunition may be used for guard purposes? *A.* Gallery practice cartridge.

Q. What is the weight of the ball cartridge? *A.* About an ounce; 100 rounds weighs about 5½ lbs.

Q. What types of service ammunition are used with the M1 rifle? *A.* Ball M2 and M1906; (2) tracer M1; and armor-piercing M1.

Q. What distinguishes armor-piercing and tracer ammunition from ball ammunition? *A.* Armor-piercing is painted black for ¼ inch from the point; tracer is painted red for ¼ inch from the point.

Q. At what distance must personnel be from the M1 rifle when firing blank ammunition? *A.* Over 20 yards.

Q. What type of dummy cartridge may be used with M1 rifle? *A.* The corrugated type of dummy cartridge (caliber .30, M1906) may be used for instructional purposes. *The use of the slotted type of dummy cartridge (range, caliber 0.30 M1)* is prohibited.

Q. What is the standard type of ball ammunition? *A.* Ball cartridge, caliber .30, M2, is standard.

53. Pistol, automatic, caliber .45, M1911 and M1911A1.—*a. Nomenclature and action.*—*Q.* What are the four main requirements for a military pistol? *A.* Accuracy within short ranges; power sufficient to stop an enemy instantly; rapidity of fire; and dependability.

Q. What models of the automatic pistol are used in the military service? *A.* Caliber .45, M1911 and M1911A1.

Q. What markings are on the pistol? *A.* On the right side, "Model of 1911 (or 1911A1), U. S. Army"; on the left side, "United States Property." All pistols are also marked with a serial number.

Q. What is meant by caliber .45? *A.* Caliber .45 means that the distance between two directly opposite lands in the barrel, expressed in inches, is 45/100 of an inch.

Q. What are the lands and grooves? *A.* The lands are the raised portions of the bore and the grooves are the spaces between the lands.

Q. For what use is this pistol intended? *A.* For emergency use at short range.

Q. What is its effective range? Its maximum effective range? Its extreme range? *A.* Its ordinary effective range is 25 yards. Its maximum effective range is placed at 75 yards. Its extreme range, if held at an angle of 30°, is about 1,600 yards.

Q. What is the muzzle velocity of the pistol, and what penetration is obtained? *A.* It has a muzzle velocity of 800 feet per second. A penetration of 1 inch in white pine corresponds to a dangerous wound. At a range of 25 yards this pistol will drive a bullet 6 inches into white pine.

Q. How many shots can be fired without reloading? *A.* Seven.

Q. How fast can it be fired? *A.* Starting with the pistol unloaded, it has been fired 21 times in 12 seconds.

Q. Which direction of twist do the lands and grooves in the bore give the bullet? *A.* A left twist, or counterclockwise as seen from the breech.

Q. How does this affect the bullet? *A.* The rotation keeps the bullet from tumbling in its flight, but also causes it to drift slightly to the left.

Q. In firing, should any allowance be made for this drift? *A.* No. At the short ranges at which the pistol is used the drift is so small that it is negligible.

Q. Name the three principal parts of the pistol. *A.* Receiver, barrel, and slide.

Q. Point out the following parts:

Receiver.	Rear sight.	Barrel bushing.
Extractor.	Disconnector.	Magazine.
Barrel.	Front sight.	Recoil spring.
Ejector.	Trigger.	Magazine spring.
Slide.	Link.	Recoil spring guide.
Firing pin.	Grip safety.	Magazine catch.
Slide stop.	Link pin.	Plug.
Hammer.	Safety lock.	

A. See figure 69.

Q. Why is this pistol called the automatic pistol? *A.* Because on being fired, the work of opening the breech, cocking the hammer, extracting and ejecting the empty shell, and forcing a new cartridge into the chamber, is done automatically by the force of recoil.

Q. Describe briefly the functioning of the pistol. *A.* The force of the explosion causes the barrel to recoil slightly. It moves rearward and down until it is stopped by the lug holding link. The slide, having been unlocked from the barrel, moves to the rear extracting and ejecting the old shell compressing the recoil spring, and cocking the hammer. The greatly compressed recoil spring then forces the slide to the forward position. During this movement the slide pushes the new bullet, which has been raised into the chamber by the action of the magazine follower into the barrel and pushes the barrel forward slightly and up, locking into the locking ribs ready for firing again.

Q. How is the pistol loaded? *A.* A loaded magazine is placed in the stock and the slide drawn fully back and released, thus bringing the first cartridge into the chamber. The hammer is thus cocked and the pistol is ready for firing.

Q. How is the pistol fired? *A.* The trigger is pulled, releasing the hammer which falls and strikes the firing pin, driving the latter forward against the percussion primer. This primer ignites the powder which propels the bullet.

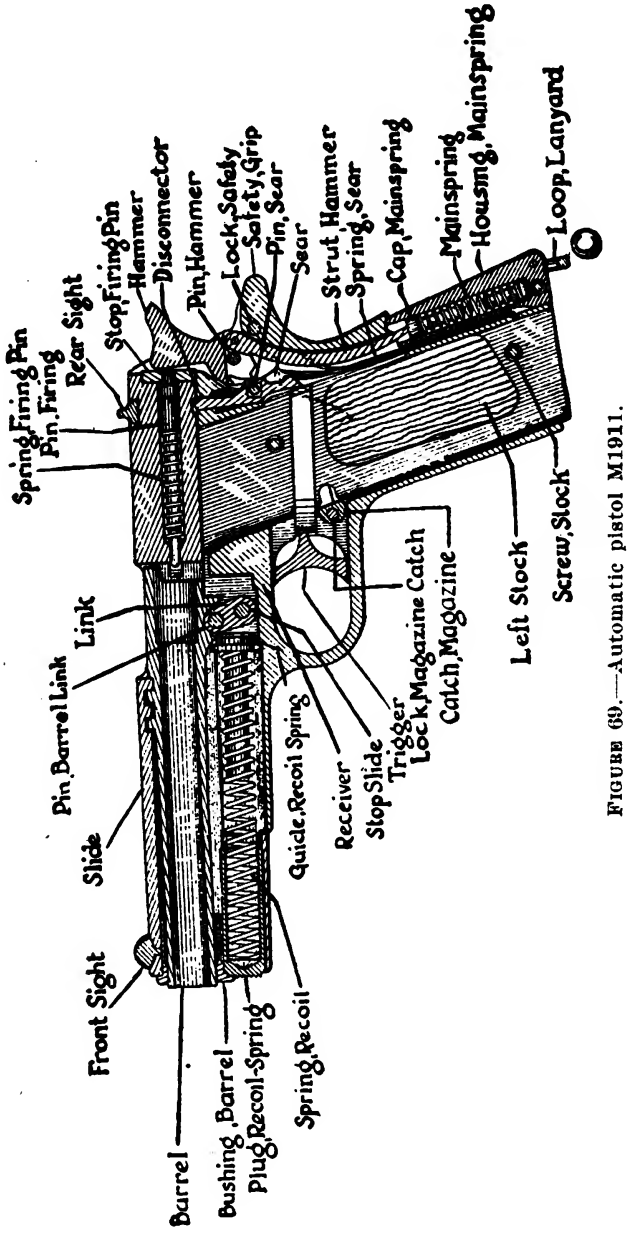
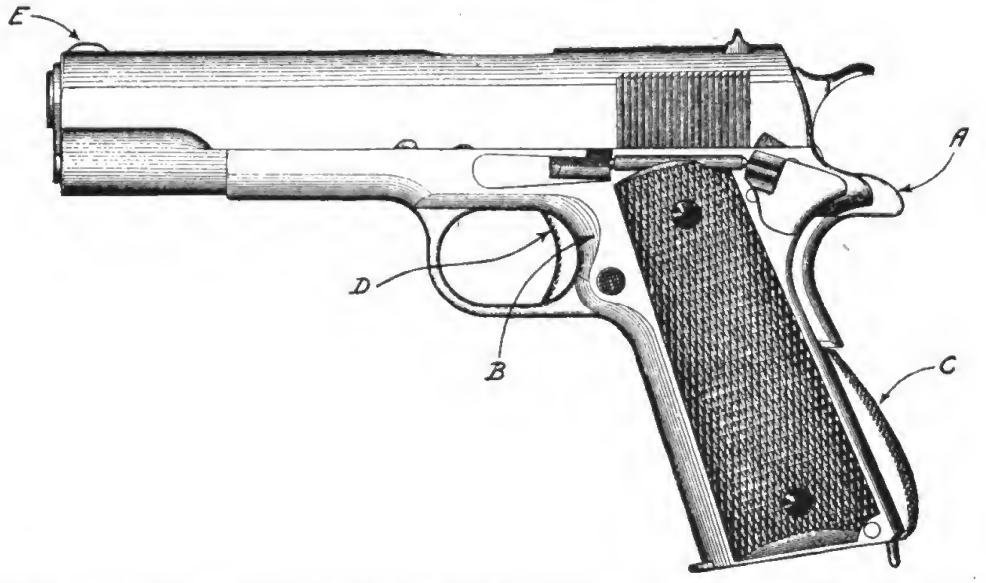


FIGURE 69.—Automatic pistol M1911.

Q. How is the pistol loaded again? *A.* The loading is automatic as long as a cartridge remains in the magazine. On recoil the slide is driven to the rear and the recoil spring is compressed. The slide moves forward again, driven by the recoil spring, and another cartridge is carried into the chamber.

Q. What are the two automatic safety devices? *A.* The *disconnector*, which positively prevents the release of the hammer unless the slide and the barrel are in the forward position and safely interlocked; this device also controls the firing and prevents more than one shot from following each pull of the trigger. The *grip safety*, which at all times locks the trigger unless the stock is firmly grasped and the grip safety pressed in.



NOTE.—Modifications over the M1911 automatic pistol are shown and indicated by letters A, B, C, D, and E.

FIGURE 70.—Automatic pistol M1911A1.

Q. What other safety devices does the pistol have? *A.* The *safety lock*, by which the closed slide and the cocked hammer can be locked positively at will; the *half cock*, which prevents firing until the pistol is fully cocked.

Q. What is the purpose of the locking ribs on the barrel? *A.* To engage in the locking grooves in the slide, thereby securely locking slide to barrel in the firing position, and preventing it from rotating when the pistol is fired.

Q. What is the function of the link? *A.* To pivot the barrel, allowing it sufficient play to rise on its slight forward movement and lock into slide, and also to fall on its rearward movement and disengage from locking grooves, letting the slide continue its movement to the rear. It holds the barrel to its position in the receiver.

Q. What is the function of the magazine follower lip? *A.* When the last bullet in the magazine has been fired, the shell is pushed up into

chamber through the action of the magazine follower spring. As the slide moves to the rear upon recoil, the lip engages the pawl on the slide stop and forces it up into slide stop slot on the lower edge of slide, locking the latter in the rearward position. This serves to remind the firer that the last shot has been fired.

Q. What is the difference between the functioning of the extractor and the ejector? *A.* The extractor catches just in front of the shell rim and pulls it back out of the barrel when the slide moves to the rear after firing. The shell strikes against the ejector, which throws it out through the breech opening.

Q. How is the pistol disassembled for cleaning? *A.*

(1) Remove the magazine by pressing the magazine catch.

(2) Press the recoil spring plug inward and turn the barrel bushing to the right until the plug and the end of the recoil spring protrude from their seat, releasing the tension of the spring.

(3) Draw the slide to the rear until the smaller rear recess in its lower left edge stands above the projection on the thumb piece of the slide stop; press gently against the end of pin of the slide stop which protrudes from the right side of the receiver above the trigger guard, and remove the slide stop.

(4) This releases the barrel link, allowing the barrel, with the link and the slide, to be drawn forward together from the receiver, carrying with them the barrel bushing, recoil spring, plug, and recoil spring guide.

(5) Remove these parts from the slide by withdrawing the recoil spring guide from the rear of the recoil spring and drawing the plug and the recoil spring forward from the slide.

(6) Turn the barrel bushing to the left until it may be drawn forward from the slide.

(7) This releases the barrel which, with the link, may be drawn forward from the slide, and by pushing out the link pin, the link is released from the barrel.

Q. How is the pistol assembled? *A.* Proceed in the reverse order. When replacing the slide and barrel on the receiver, care must be taken that the link is tilted forward as far as possible and that the link pin is in place.

Q. How should one grasp the pistol for firing? *A.* To take the grip, hold the pistol in the left hand and force the grip safety device down and back into the crotch formed by the thumb and forefinger of the right hand. The thumb is carried parallel with or slightly higher than the forefinger, it should never be lower. Close the three lower

fingers on the stock firmly but not with too tight a grip. The muscles of the arm are held firm but not rigid.

Q. How should one hold the breath while firing? *A.* To hold the breath, draw into the lungs a deep breath, let out a little of the air, and stop the rest by closing the throat. Do not hold the breath with the throat open or by muscular effort of the diaphragm.

Q. What should be the position of the body? *A.* The body is a little more than half faced to the left, the feet 12 to 18 inches apart, depending on the man, and the body is perfectly balanced when the pistol is held in the shooting position. The whole position should be natural and comfortable.

Q. How should one squeeze the trigger? *A.* The trigger is squeezed with a steady increase of pressure so as not to know when the hammer will fall. It is squeezed only when the sights are alined on the target.

Q. How should the sights and the bull's-eye appear when the pistol is fired? *A.* The front sight should appear vertically in the center of the rear sight with its top level with the top of the rear sight. The bull's-eye should appear to rest on the top of the front sight.

b. Maintenance of pistol.—Q. What causes the most damage to a pistol when it is not properly cared for? *A.* Water and perspiration. If allowed to remain on the metal parts of a pistol it will form rust and the surface of the metal will become "pitted."

Q. How is a pistol protected from water and perspiration? *A.* By removing all moisture from the metal parts and covering them with a coating of oil or grease.

Q. How is a pistol cleaned after daily drill? *A.* Rub the outside, including the stock, with a rag that has been slightly oiled, and then clean it with a perfectly dry rag. Swab the bore with an oily flannel patch and then with two or three perfectly dry ones. Dust out all screw heads and crevices with a small clean brush.

Immediately after cleaning, swab the bore with a flannel patch saturated with oil (or grease), finally drawing the patch smoothly through the bore and out of the chamber, allowing the cleaning rod to turn with the rifling. Wipe over all metal parts, including the mechanism and magazine, with an oily rag, and put a few drops of sperm oil on all cams and working surfaces.

Q. Should a pistol be stored in a gun rack (or any other place) without a protective coating of oil? *A.* No. Even a perfectly clean and dry weapon will soon collect moisture which will damage the metal parts unless they are protected with oil or grease.

Q. Why should a pistol be cleaned after daily drill? *A.* Because handling the weapon removes oil and allows moisture from the hands to get on it.

Q. What tool may be used for tightening or loosening screws? *A.* Only a properly fitting screw driver. Never use a substitute because it will damage the screwheads.

Q. Should a pistol be cleaned before firing? *A.* Yes. Always wipe out the bore with a clean patch before going to the firing point. See that no dust, dirt, mud, snow, rags, patches, or other obstructions are in the bore before firing.

Q. What are the three main forms of residue left in the bore after a pistol is fired? *A.*

(1) A coating of chemicals left by the burned powder.

(2) Particles of unburned or partially burned powder, called powder fouling.

(3) Particles of metal from the jacket of the bullet, called metal fouling.

Q. How does this residue damage a pistol if not removed? *A.* The chemicals attract moisture from the air which collects in the bore. The powder fouling and the metal fouling trap moisture underneath against the bore. The moisture causes rusting and pitting of the bore.

Q. How is a pistol cleaned after firing? *A.*

(1) The chemicals and powder fouling are dissolved by scrubbing the bore with a dissolving solution of hot water and issue soap or a sal soda solution. Hot water alone may also be used. (Cold water is used only when none of the other agents are available.)

(2) Remove the barrel of the pistol and place the muzzle in a vessel containing the dissolving solution. Using a cleaning rod and a flannel patch inserted from the breech, pump the solution back and forth through the bore for about one minute. Next place a brass or bronze wire brush on the rod and run it through the bore all the way down and back three or four times, leaving the muzzle in the dissolving solution. A wire brush is necessary to remove the powder fouling thoroughly. Next remove the brush from the rod and swab several more times with the dissolving solution. Then wipe the cleaning rod dry, remove the muzzle from the solution and, using dry clean flannel patches, thoroughly swab the bore until it is perfectly dry and clean. Also dry off the chamber and other metal parts thoroughly.

(3) Finally, inspect the bore for metal fouling (see below). If no metal fouling is present, prepare the weapon for storage as you do after daily cleaning and place it in the gun rack.

Q. How is the bore inspected for metal fouling? *A.* Hold the butt of the pistol pointed toward the sky and examine the bore from the muzzle, with the eye about 8 inches from the muzzle. If small smears, flakes, or lumps looking like dull lead are seen on the surface of the bore, this is metal fouling.

Q. What do you do in case you find metal fouling? *A.* Take the pistol to the supply sergeant and ask for instructions.

Q. How is metal fouling removed? *A.* It is removed with metal fouling solution which must be used only by qualified ordnance personnel.

Q. How soon after firing should a pistol be cleaned? *A.* When a pistol has been fired, the bore should be cleaned thoroughly not later than the evening of the day on which it is fired. Thereafter it will be cleaned and oiled each day for at least the next three succeeding days.

Q. What oils can be used on pistols? *A.* Sperm oil for lubrication and medium rust-preventive compound for protection from rusting. No other oils should be used unless authorized by the battery commander or his representative.

Q. State some of the things one is prohibited from doing with a pistol. *A.*

(1) Aside from the removal of those parts permitted for cleaning, a pistol will not be disassembled except by permission of a commissioned officer, and then only under the supervision of a qualified person who knows the provisions contained in the ordnance pamphlet on the subject.

(2) Blued or browned parts of pistols must not be polished.

(3) All mutilations are prohibited.

(4) Nothing except the authorized oils may be used on a pistol.

(5) Weapons must be unloaded before being taken into barracks or tents.

c. Ammunition.—*Q.* What are the parts of the cartridge? *A.* Cartridge case, primer, powder, bullet.

Q. What is the purpose of the primer? *A.* To ignite smokeless powder.

Q. Of what does the bullet consist? *A.* A core of lead and tin composition inclosed in a jacket of cupro-nickel; weight 230 grains.

Q. What is the weight of the cartridge and bullet complete? *A*. About ¾ ounce; 100 rounds weigh about 4½ pounds.

Q. How is ammunition packed? *A*. The cartridges are packed in pasteboard boxes containing 20 cartridges each. One hundred pasteboard boxes, or 2,000 cartridges, are packed in one zinc case, hermetically sealed, with handle for tearing open. The whole is inclosed in a wooden chest, the cover of which is fastened with screw hooks and thumb nuts and sealed.

Q. What types of cartridges are provided for this pistol? *A*. Ball cartridge, caliber .45, M1911 and dummy cartridge, caliber .45, M1921. The dummy cartridge case is tinned and has a ⅛-inch hole in the body.

CHAPTER 9

CORDAGE AND MECHANICAL MANEUVERS

54. Definitions.—*a. General.*—Rigging involves the technique of handling manila and wire rope and chains in various block and tackle combinations to raise and move heavy loads. It is closely related to the handling of loads by jacks, levers, and similar mechanical devices.

b. Special terms.

Belay.—To make a turn or turns with a running end of rope around a spar, cleat, or the standing part of the rope.

Bight.—Loop formed on rope so that the two parts lie alongside each other or cross.

Frapping.—Drawing together of several turns by passing a rope around all the turns.

Mousing a hook.—Securing a load held in the hook by wrapping cord or twine across its mouth in such a way as to close it effectively.

Paying out.—Giving slack in rope.

Running end.—Free end of rope.

Seizing.—Lashing the running end back to the standing part.

Standing part.—Whole rope less the running end.

Thief.—Knot commonly mistaken for a reef knot, differing in that the end of each rope turns around the standing part, instead of around the other rope.

Transom.—Horizontal spar.

Unlaying.—Untwisting of the strands or cords.

Upright.—Vertical spar.

Whipping.—Wrapping an end tightly with cord or twine to prevent its unlaying when pulled through a pulley or other small opening.

55. Characteristics of knots.

Name	Use	Directions for tying
Overhand	At end of rope to prevent unlaying or to prevent end from slipping through block.	See figure 71.
Figure-of-eight	Same as above	See figure 71.
Square or reef [1]	To join two ropes of same size.	See figure 71. Pass standing and running parts of each rope through loop of the other in the same direction. Ends of each rope turn around end of other, rather than standing part.
Single sheet bend or weavers.[2]	To join ropes, especially of unequal size.	See figure 71.
Double sheet bend [3]	To join ropes of unequal size, especially wet ones.	See figure 71.
Two half hitches [4]	To belay or make fast end of rope around own standing part.	See figure 71. End may be lashed down or seized to standing part to prevent slipping.
Round turn and two half hitches.	Same as above	See figure 71.
Fisherman's bend or anchor.	To fasten a rope to a ring or anchor.	See figure 71. Take two turns around the iron, then a half hitch around the standing part and between the ring and the turns, then half hitch round standing part.
Clove hitch	To fasten a rope at right angles to a spar or at beginning of lashing.	See figure 71. If end of spar is free, hitch made by first forming two loops, placing right hand loop over other, and slipping the double loop over the end of the spar. Otherwise, pass end of rope around spar, bring it up to the right of standing part, cross over latter, make another turn around spar, bring up the end between spar last turn and standing part.

[1] Care must be taken not to tie a thief or granny, as these will slip.
[2] More secure than a reef but more difficult to untie.
[3] More secure than a single sheet bend.
[4] Must not be used for hoisting a spar.

Name	Use	Directions for tying
Timber hitch [5]	To haul or lift spar	See figure 72.
Telegraph hitch	To hoist or haul spar	See figure 72.
Hawser bend	To join two large cables	See figure 72. Each end is seized to own standing part.
Bowline [6]	To form a loop that will not slip.	See figure 72. Make loop standing part underneath, pass end from below through loop, over the part, around the standing part, then down through the loop.
Bowline-on-a-bight	To make a comfortable sling for a man.	See figure 72. Make first part as above with double part of rope, then pull bight through sufficiently to allow it to be bent past loop and come up in proper position.
Running bowline	To make a slip knot that will not bind.	See figure 72. Pass end around spar. Form a loop around the standing part with the running end. Make a bowline on the standing part below the loop on the running end side.
Cat's-paw	To secure a rope to the mouth of a hook.	See figure 73. Form two equal bights; take one in each hand and roll them along the standing part till surrounded by 3 turns of the standing part; then bring both loops (or bights) together and pass over the hook, and mouse the hook.
Sheep shank	To shorten a rope or pass a weak spot.	See figure 73. Take a half hitch with the standing parts around the bights.
Rolling hitch	To haul a larger rope or cable.	See figure 73. Take two turns around the large rope in the direction in which it is to be hauled, and one half hitch the other side of the hauling part.
Blackwall hitch	To attach a single rope to a hook of a block for hoisting.	See figure 74.

[5] Can be easily loosened when strain is taken off, but will not slip under load. When used for hauling spars, a half hitch is added near end of spar.
[6] Length of bight depends on purpose for which knot is required.

Name	Use	Directions for tying
Mooring knot	To make fast to a mooring or snubbing post.	See figure 74. Take 2 turns around the mooring or snubbing post, pass the free end under the standing part, take a third turn above the other, pass the free end between the two upper turns.
Carrick bend	To fasten guys to derricks.	See figure 74.
Wall knot and crown on wall.	To furnish the end of a rope to prevent unlaying.	See figure 74.

56. Splices.—*Q*. What is the purpose of a short splice? *A*. Short splices are used to join two ropes when an increase in diameter at point of splice is not objectionable.

Q. How is a short splice made? *A*. Unlay the strands of each rope for a convenient length. Bring the rope ends together so that each strand of one rope lies between the two consecutive strands of the other rope. Draw the strands of the first rope along the second and grasp with one hand. Then work a few strands of the second rope over the nearest strand of the first rope and under the second strand, working in a direction opposite to the twist of the rope. Apply the same operation to all strands. Splicing may be continued in the same manner to any extent, and the free ends may be cut off when desired. Splice may be tapered by cutting out a few fibers from each strand each time it is passed through the rope. Splice may be made compact by rolling under a board or under the foot.

Q. What is the purpose of a long splice? *A*. Long splices are used to join two ropes without an increase in diameter at point of splice.

Q. How is a long splice made? *A*. Unlay the rope and bring together as for a short splice. Unlay to a convenient length a strand (*a*, fig. 75) of one rope, laying in its place the nearest strand (*d*) of the other rope. Repeat the operation in the opposite direction with two other strands (*c*) and (*f*). Lay half of one in place of the unlayed half of the other. Pass the tops through the rope. When the splice has been thoroughly stretched, trim off the ends of the strands.

Q. What is the purpose of an eye splice? *A*. Eye splices are used for fastening a rope to a ring or for making a permanent loop in the end of a rope.

Q. How is an eye splice made? *A*. Unlay a convenient length of rope. Pass one loose strand under one strand of the rope, forming an eye of the proper size. Pass a second strand under the strand

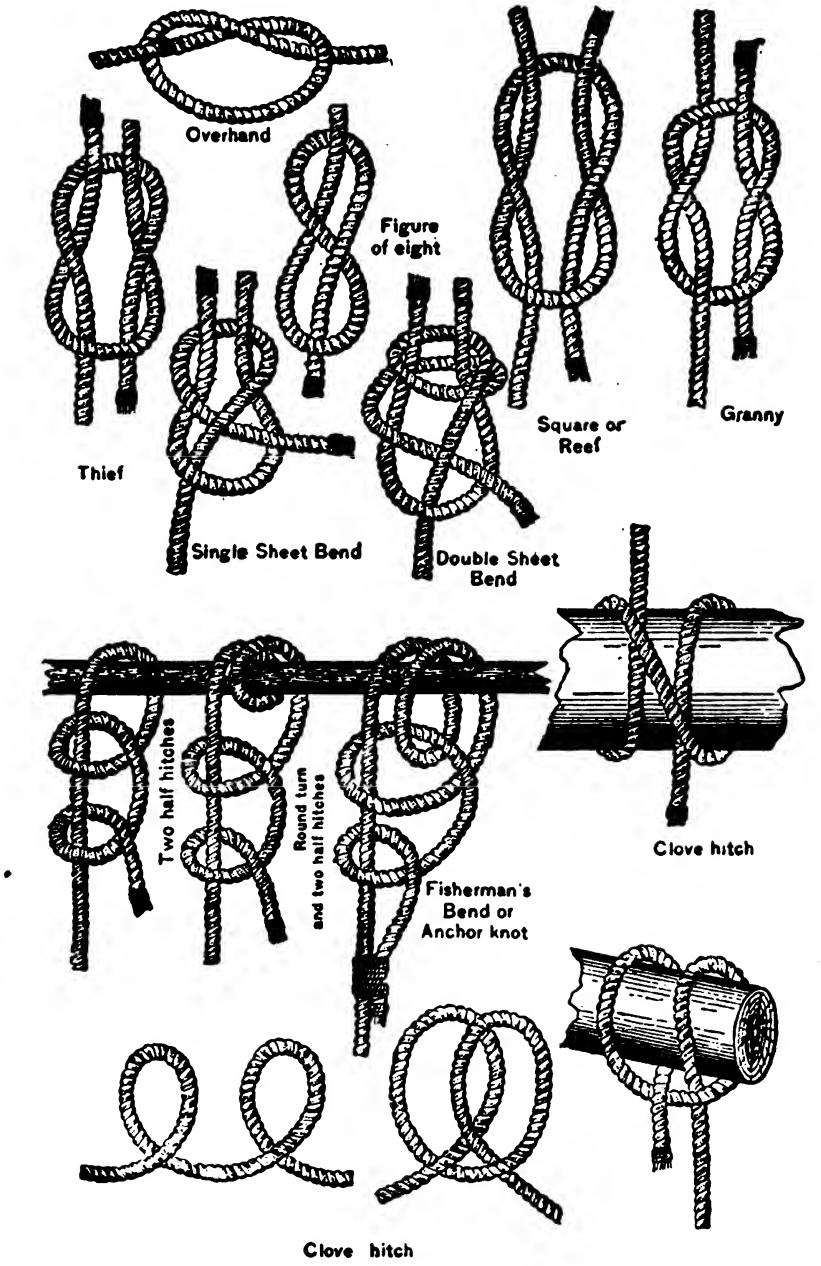


FIGURE 71.—Types of knots—hitches, bends, overhand, etc.

of the rope next to the strand which secures the first one. Pass the third strand under the one next to that which secures the second strand. Draw all taut, and continue as for a short splice.

57. Cordage.—*Q.* What is a cord rope? *A.* A rope made of vegetable fibers. These fibers are twisted together to form strands, and several strands are twisted together to form a rope.

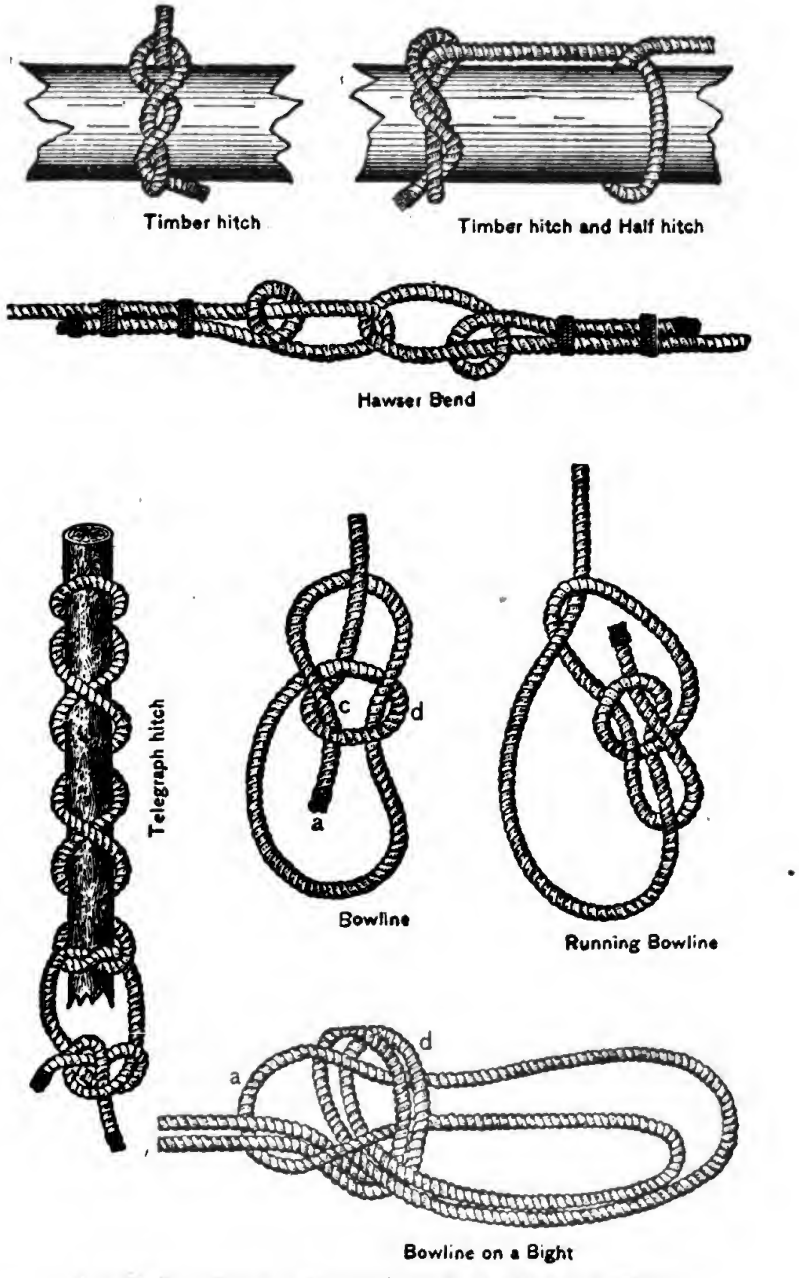


FIGURE 72.—Types of knots—hitches, bends, and bowlines.

Q. What is a wire rope? *A.* A rope of steel, or other metallic wire. A number of wires (usually 19) are twisted into strands and several (usually six) of these strands are laid around a hemp core.

Q. What is the purpose of the hemp core. *A.* To prevent the steel strands from rubbing against and cutting into each other, and to give flexibility to the rope.

Q. How is a rope designated as to size? *A.* By its circumference or diameter in inches.

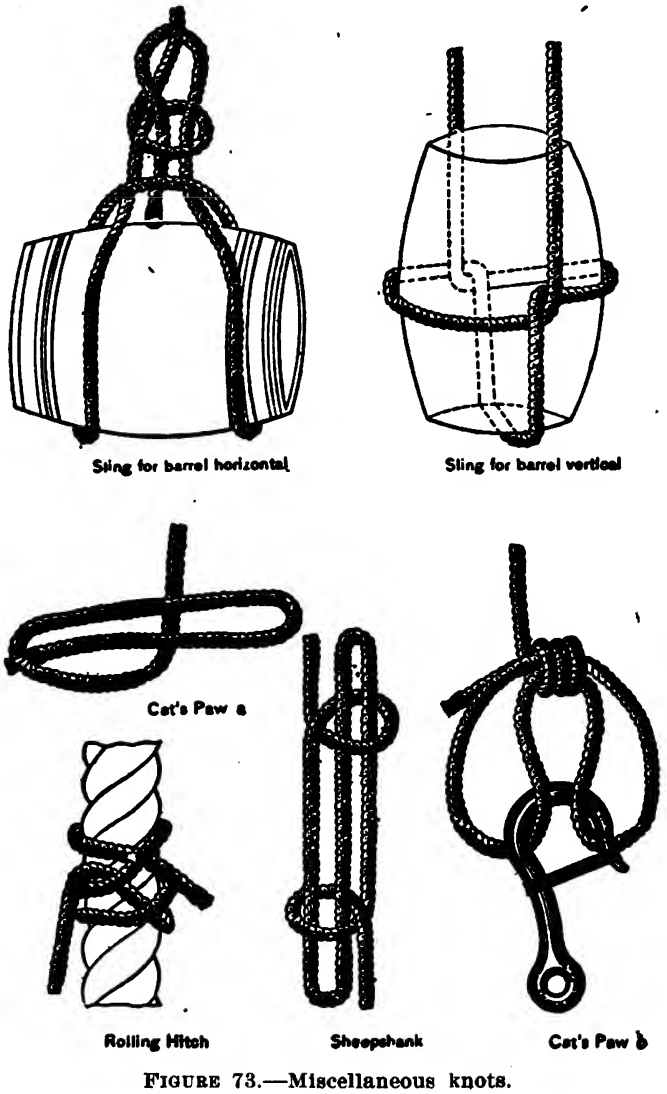


FIGURE 73.—Miscellaneous knots.

Q. What is marline; seizing stuff? *A.* Marline and seizing stuff are both small-sized cordage. Marline is usually two stranded and laid up left-handed. Seizing stuff is made of better material and is usually three stranded, right-handed.

Q. How should cord rope be stored? *A.* In coils on skids or blocks so as to permit the circulation of air about the coil. Cord rope should never be stored wet.

Q. How is the strength of cord rope affected when slung over hooks or fastened by knots? *A.* The strength is lowered about one third.

Q. What care should be used in uncoiling new rope? *A.* Care should be used to find the natural lay of the rope and relieve the twist.

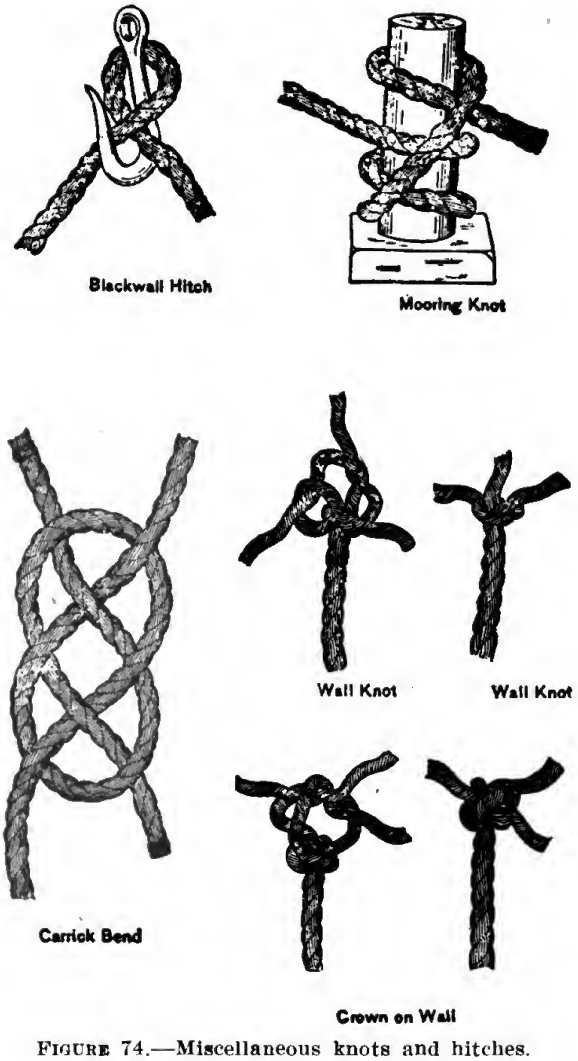


FIGURE 74.—Miscellaneous knots and hitches.

Q. How can rope be identified as right- or left-handed? *A.* By comparing it with a right- or left-handed screw thread.

Q. How should rope be coiled? *A.* Rope should be coiled right- or left-handed according to whether it is right- or left-handed rope.

Q. How should rope be cared for while in storage? *A.* It should be taken out at least once each year, dried, stretched, and all weak spots cut out.

Q. What precaution should be taken before using old rope? *A*. It should be tested, especially when serious damage might result from its breakage.

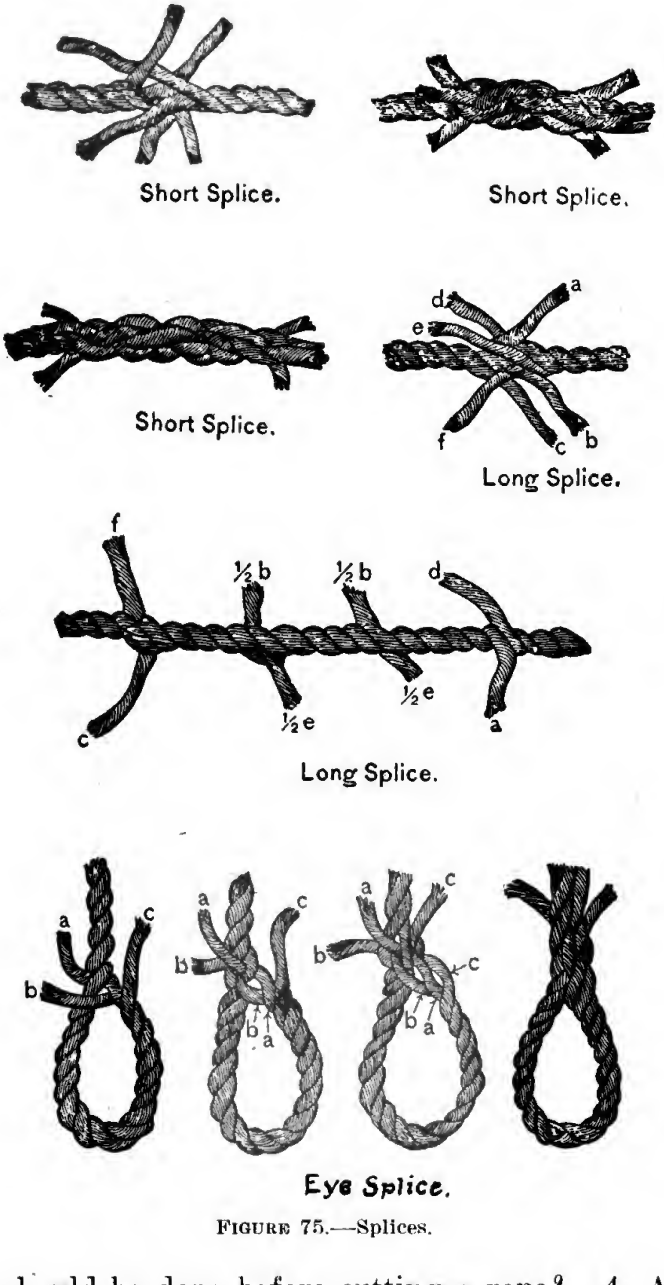


FIGURE 75.—Splices.

Q. What should be done before cutting a rope? *A*. A whipping should be placed on each side of the spot where the rope is to be cut. The end of the rope should never be left free to unlay or ravel.

Q. Demonstrate a wall knot, figure-of-eight, bowline, anchor knot, bowline-on-a-bight, sheepshank, cat's-paw, square knot, rolling hitch,

clove hitch, blackwall hitch, timber hitch, and sheet bend. Explain the use of each. *A.* See paragraph 55.

Q. How is wire rope coiled? *A.* Small size wire rope may be coiled in the same manner as cord rope. Large wire rope should be coiled in a figure eight.

Q. What is the principle precaution to be taken in using a wire rope? *A.* Never let it become kinked while under a strain.

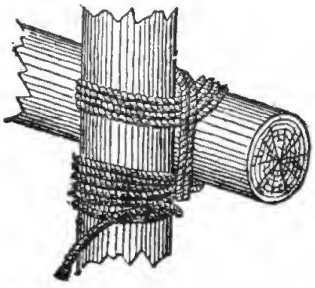


FIGURE 76.—Square lashing.

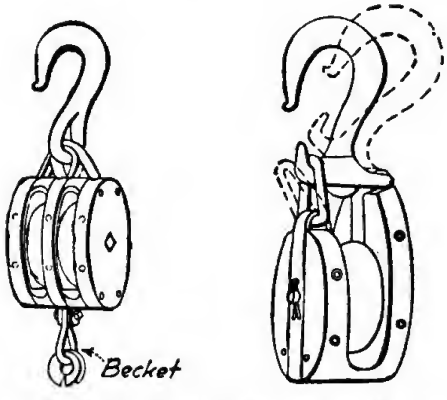


FIGURE 77.—Double wooden block and snatch block.

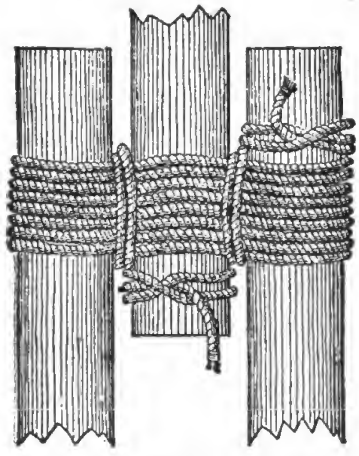


FIGURE 78.—Lashing for tripod.

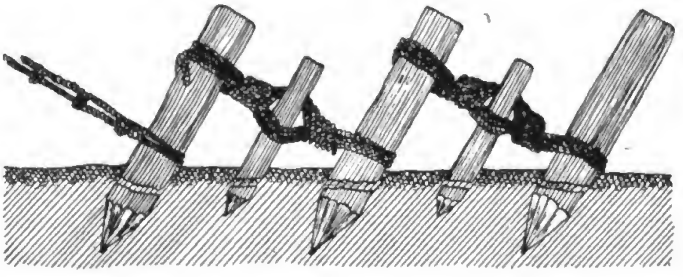
Q. Name the component parts of a clip. *A.* The roddle, the U-bolt, and the U-bolt nuts.

Q. How should wire rope be attached? *A.* Normally wire rope should be attached with thimble and clips. The rope may be secured around the thimble by splicing, but this requires expert work. In the absence of clips a seizing of wire may be used.

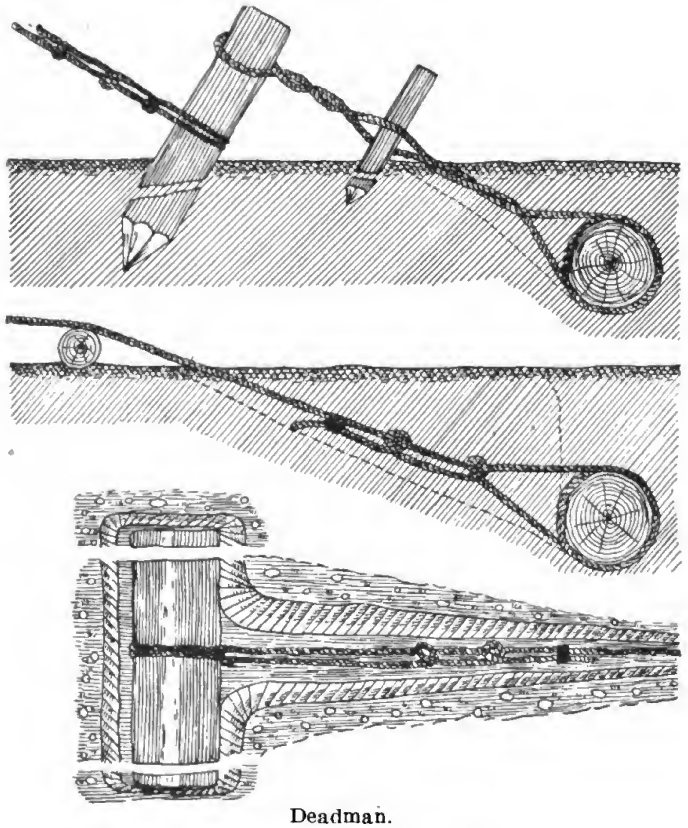
Q. What precautions must be taken when using wire rope attached with thimble and clips.? *A.* See that the roddles of all clips are in

contact with the *long* end of the rope (fig. 82). After the wire rope has been subjected to strain, the clip bolts must be tightened.

58. Blocks and tackle.—*Q.* What is a block? *A.* A block consists of a shell or frame of metal, or wood and metal, housing a



Holdfasts.



Deadman.

FIGURE 79.—Anchorages.

grooved pulley or sheave on which rope runs, and giving support to the ends of a pin on which the sheave revolves. A hook, usually free to revolve (swivel), may be attached to one end of the block and often an eye or becket to the other end.

Q. What are the parts of a block? *A*. The parts of a block are the shell or frame, the sheave or wheel upon which the rope runs, and the pin upon which the wheel turns in the shell.

Q. How are blocks designated? *A*. Blocks are designated by the length of the shell in inches and by the number of sheaves. Those

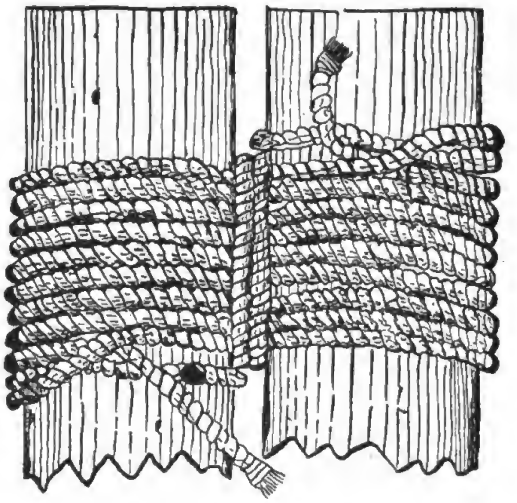


FIGURE 80.—Lashing for shears.

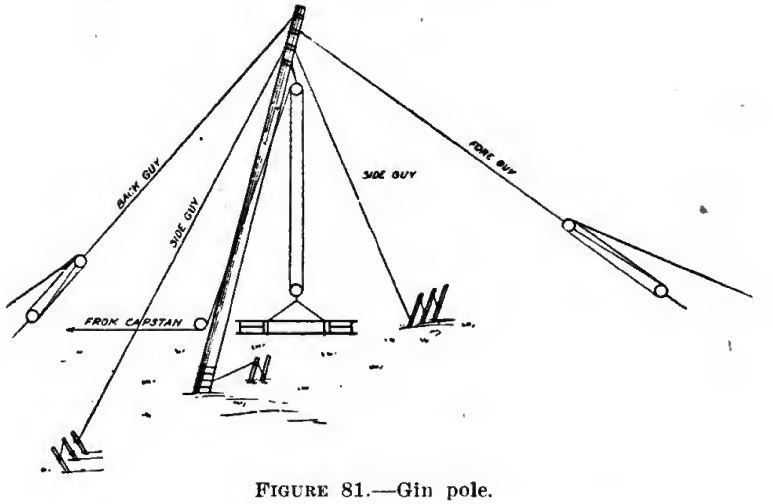


FIGURE 81.—Gin pole.

with one, two, three, or four sheaves are called single, double, triple, and quadruple. The smallest size of block (length in inches) that will take a given rope is nine times the rope diameter. Self-lubricating blocks should be used where obtainable.

Q. Define the following:

Snatch block.—A snatch block is a single block with the shell open at one side to admit a rope without passing the end through.

Running block.—A running block is a block that is attached to the object to be moved.

Standing block.—A standing block is a block that is fixed to some permanent object.

Simple tackle.—A simple tackle consists of one or more blocks rove with a single rope.

Return.—Each part of the rope between the two blocks, or between either end and the block, is called a return.

Overhaul.—To overhaul is to separate the blocks.

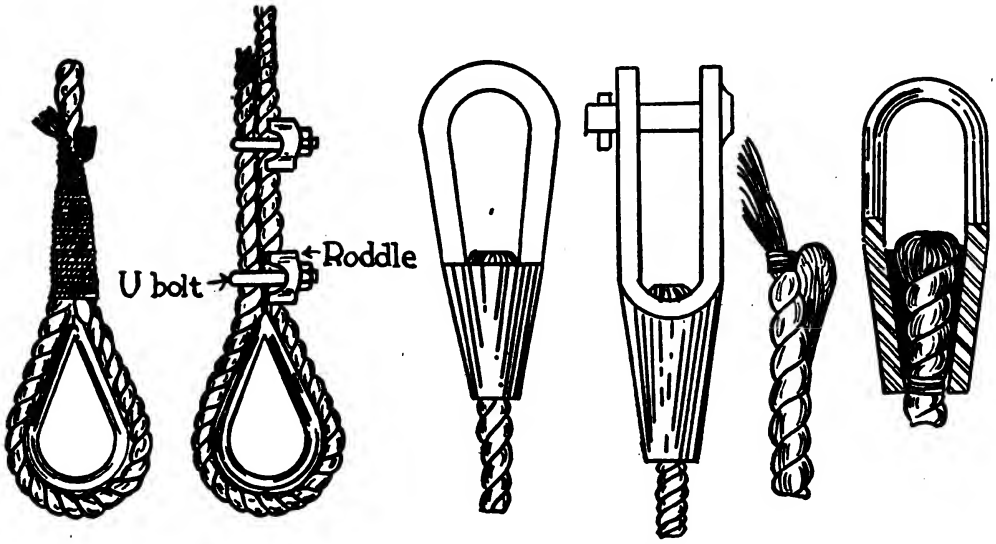


FIGURE 82.—Wire rope fittings.

Round in.—To round in is to bring the blocks closer together.

Chockablock.—When the blocks are in contact, the tackle is said to be chockablock.

Q. What is the purpose of blocks? *A.* Blocks are used to change the direction of pull and to give mechanical advantage. A man of average weight will pull about 60 pounds horizontally.

Q. What is a tackle? What are the different parts? *A.* A tackle is a rope and block or a combination of ropes and blocks working together for use in lifting or moving objects. The standing part of a tackle is that part of the rope between the end which is made fast to one of the blocks, to the weight to be moved, or to some fixed point and the point where it passes over the first sheave. The running part of the rope consists of all the parts moving between the sheaves. The fall is that part of the rope to which the power is applied. A moving block is called a running block and a fixed block is called a standing block.

Q. What is meant by the power or mechanical advantage of a tackle? *A.* The ratio of the load to the power required to lift or move it. Thus if a man weighing 150 pounds can just lift a 600-pound weight with a certain tackle, the power of the tackle is 4.

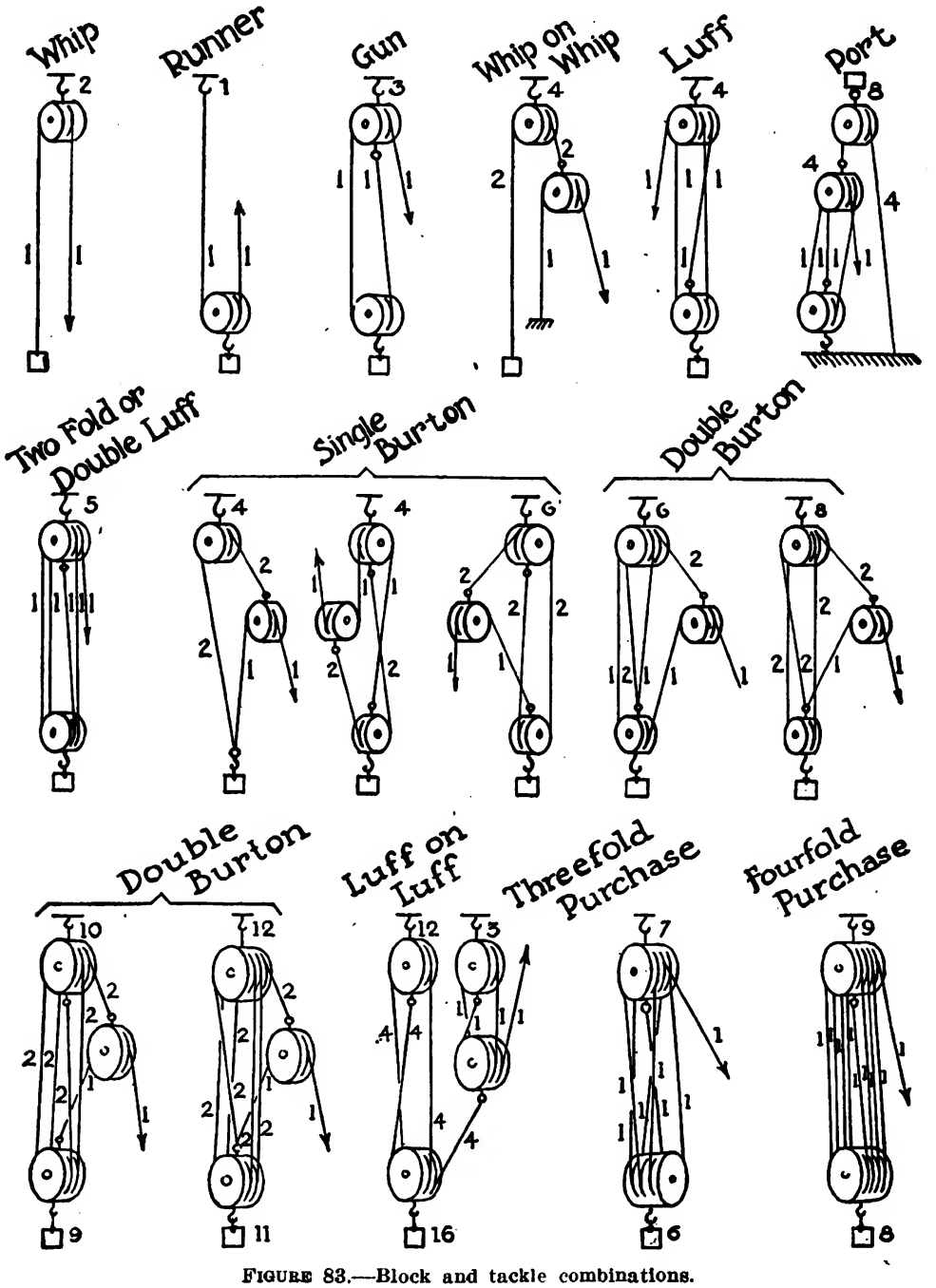


FIGURE 83.—Block and tackle combinations.

Q. What mechanical advantage is gained by the use of blocks? *A.* In simple tackles the mechanical advantage gained is a direct function of the number of ropes supporting the load. Thus, if the movable block is a double one, then four ropes will sustain the load and the mechanical advantage gained is 4.

Q. Draw sketches showing: a whip tackle; a whip on a whip; a runner; a gun tackle; a luff tackle; and show the power of each. *A.* See figure 83.

Q. Why is a runner a more powerful tackle than a whip? *A.* Because the pull is in the same direction as that in which the load is moved instead of in the opposite direction.

Q. Rig a whip tackle; gun tackle; luff tackle.

Q. What is a chain or triplex block? *A.* A chain or triplex block consists of a train of gears operated by a large wheel over which an endless chain passes. Power is applied to this chain. The gears operate a sprocket wheel over which runs a heavy chain, the links of which fit into the sprockets. The heavy chain lifts the weight and is provided with a hook for supporting the weight. Chain blocks are rated according to their lifting capacities and range by half-ton changes from one to five tons.

59. Slings.—*Q.* What are slings made of? *A.* Slings are made of manila rope, wire rope, or chains. The most common is a manila sling made by splicing the two ends together.

Q. How is a sling used? *A.* To use a sling, pass it around the article to be lifted. Pass the bight formed by one end through the bight formed by the other and then over the lifting hook. If the sling is the same size as the lifting rope, it should make a minimum angle of 30° with the horizontal. At this angle the stress in each branch of the sling is equal to the stress in the lifting rope. If the angle is greater than 30° the load is limited by the strength of the lifting rope; if less than 30° by the strength of the sling.

Q. How do you make a barrel sling? *A.* To sling a barrel horizontally, make a bowline with a long bight. To sling a barrel vertically, make an overhand knot on top of the two parts of the rope; open out the knot and slip each half of it down the sides of the barrel; secure with a bowline.

60. Lashings.—*Q.* How should two spars be lashed at right angles? *A.* Make a clove hitch around the upright a few inches below the transom. Bring the lashing under the transom, up in front of it, horizontally behind the upright down in front of the transom, and back behind the upright at the level of the bottom of the transom and above the clove hitch. Keep the following turns outside the

previous ones on one spar and inside on the other, not riding over the turns already made. Make four more turns. Make two frapping turns between the spars, around the lashing, and finish the lashing off either around one of the spars or any part of the lashing through which the rope can be passed. Do not make the final clove hitch around the spar on the side toward which the stress is to come, as it may jam and be difficult to remove. While tightening, beat the lashing with a handspike or pick handle. This is called a square lashing.

Q. How should two spars be lashed for a pair of shears? *A.* Lay the two spars alongside each other with the points below which the lashing is to be made resting on a skid. Make a clove hitch around one spar, and take the lashing loosely eight or nine turns about the two spars, above the clove hitches, without riding. Make two or more frapping turns between the spars, and finish the lashings off with a clove hitch above the turns on one of the spars. Open the butts of the spars and pass a sling over the fork. Hook or lash a block to this sling. Make fast fore and back guys with clove hitches to each spar just above the fork.

Q. How should three spars be lashed for a gin or tripod? *A.* Mark on each spar the location of the center of the lashing. Lay two of the spars parallel to each other with an interval a little greater than the diameter of a spar. Rest their tips on a skid and lay the third spar between them with its butt in the opposite direction so that the marks on the three spars will be in line. Make a clove hitch on one of the outer spars below the lashing and take eight or nine loose turns around the three. Take a couple of frapping turns between each pair of spars in succession and finish with a clove hitch on the central spar above the lashing. Pass a sling over the lashing and the tripod is ready for raising.

61. Gins and shears.—*Q.* Describe a gin. *A.* A gin is a tripod of poles or spars. The two outside poles are called legs and the third called the pry pole. A gin requires no guys.

Q. What is a gin used for? *A.* For lifting heavy weights vertically.

Q. Name the different parts of a garrison gin. *A.* Two legs, pry pole, bolt and clevis, windlass and ratchet, two handspikes, three shoes, two braces, and tackle.

Q. How much can be lifted safely with it? *A.* About 17,000 pounds.

Q. Explain briefly how a garrison gin is assembled and raised. *A.* The legs and pry pole are laid on the ground with the heads together and in position for assembling. The head is then assembled by putting the pin through the legs, pry pole, and clevis. The windlass is

put in place and the braces are brought up and put in their places. The gin is raised, after assembly, by raising the head and bringing up the foot of the pry pole toward the feet of the two legs. (See fig. 81.)

Q. Describe the shears. *A.* Shears consist of two spars, of a size suitable for the weight to be raised, lashed together at the fork. A tackle is fastened to the lashing by a strap or otherwise, the hook is moused, and holdfasts are required.

Q. What are shears used for? *A.* Shears are used for lifting heavy weights to move them a short distance, as in loading or unloading a ship or railroad car.

Q. How are shears held in position after being raised? *A.* By means of guys. (Lines from the top of the shears to holdfasts on the ground.)

Q. How are the shears raised? *A.* If not too heavy, lift the head and haul in on the proper guys. If too heavy to raise in this way, form a crutch by lashing together two poles near their upper ends, the feet of the crutch being slightly in rear of the heels of the shears and secured to prevent them from slipping. Lay the rear guy over the crutch and raise the crutch by means of two light guy ropes, until it is inclined at an angle of about 45° to the front. Haul on the rear shear guy, allowing the crutch to rise as the shears rise. After the shears are raised high enough so that the crutch ceases to act, it is lowered by means of its guy ropes. Footings should be prepared for heavy shears on hard ground, and the legs should be connected by a lashing to prevent spreading.

Q. How is a load moved horizontally by means of shears? *A.* By slacking off on one guy and taking up on the other. Tackle may be used for this purpose if necessary.

62. Anchorages.—*Q.* What is the purpose of an anchorage? *A.* It furnishes a holdfast for the tackles or guy cables in handling heavy loads by means of tackles, gins, shears, etc.

Q. Describe two forms of anchorages. *A.* The picket holdfast is a succession of pickets driven into the ground in continuation of the guy or cable and at right angles in a vertical plane to the line of pull, connected from the top of one picket to the bottom of the next, with the direct pull on the bottom of the first picket. A deadman is a log, rail, or other arrangement buried in the ground, horizontally at right angles to the line of pull, which is applied to the center of the deadman.

Q. What is the purpose of a holdfast? *A.* Holdfasts are used to anchor a line to the ground, as for a guy.

Q. How is a holdfast made? *A.* Drive stout pickets into the ground, one behind the other, in the line of pull. Secure the head of each

picket, except the last, by a lashing to the one behind it. Tighten the lashings by rack sticks, and then drive the points of these into the ground to hold them in position. The distance between pickets should be several times the height of the picket above the ground. A single good ash picket, 3 inches in diameter, driven 5 feet into good solid earth, will stand a pull of about 700 pounds.

Q. What is the purpose of a deadman? *A.* A deadman has the same use as a holdfast except that it has greater strength, but requiring more labor to construct.

Q. How is a deadman prepared? *A.* Lay a log or timber in a transverse trench with an inclined trench intersecting it at its midpoint. Pass the cable down the inclined trench, take several turns around the log, and fasten the cable to the log by half hitches and marline stopping. If the cable is to lead horizontally or incline downward, pass it over a log at the outlet to the inclined trench. If the cable is to lead upward, the log is not necessary, but the deadman must be buried deeper. The strength of the deadman depends upon the strength of the log and holding power of the earth.

Q. How can you determine the holding power of a deadman? *A.* For given cable pull, the number of square feet of deadman bearing surface required is determined by dividing the total pull to be placed on the deadman by the value given for the depth and cable inclination selected in table LXVI, FM 5–10.

63. Jacks.—*Q.* Name two types of jacks. *A.* Screw jacks and hydraulic jacks..

Q. What is the usual maximum lift of a screw jack? *A.* Usually from 16 to 18 inches. Care should be taken that it is not screwed too high.

Q. What liquid is used for filling hydraulic jacks? *A.* A mixture of alcohol and water.

Q. How would you determine what mixture of fluid to put into a hydraulic jack? *A.* Consult the manufacturer's handbook or operational instructions.

Q. Can all hydraulic jacks be used in both the horizontal and vertical positions? *A.* No. They are manufactured in two classes, horizontal jacks and base jacks. Horizontal jacks may be used in any position. Base jacks are used in the upright position, but may be inclined provided that the head is always kept higher than the base.

Q. How may the two classes of jacks be distinguished? *A.* They may be distinguished by the fact that the base jack has the pump and reservoir within the ram while the horizontal jack, which is

the shorter one, has a separate piece for the cylinder which has no connection with the reservoir except through the pump and the lowering passage.

Q. How is the hydraulic jack filled? *A.* To fill the hydraulic jack start with the ram down. Remove the lowering valve and hexagonal cap. Fill through the large hole. Small amounts necessary to replace liquid which has leaked out may be put in by removing the small screw and filling.

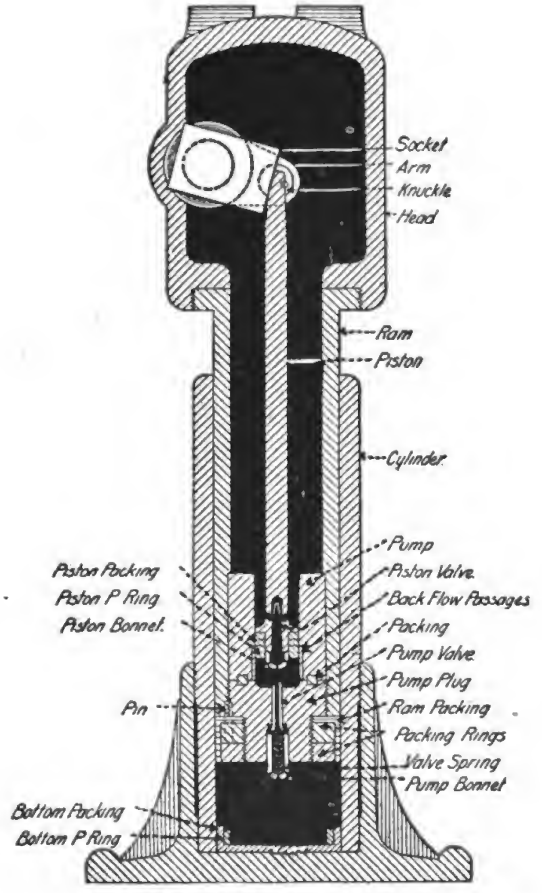


FIGURE 84.—Base jack.

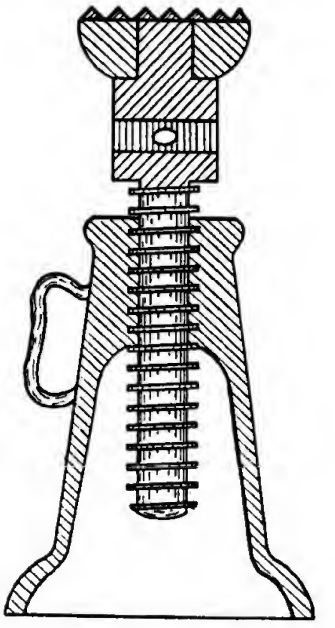


FIGURE 85.—Screw jack.

Q. How is the hydraulic jack emptied? *A.* To empty, have the ram down, place the finger over the escape hole in the cylinder, pump the ram until the bottom of it is above the hole, then open the lowering valve and remove the finger from the escape hole, allowing air to enter under the ram. The ram may now be lifted out. Remove the lowering valve and hexagonal cap and invert the jack to allow the liquid to run out.

Q. What general precautions should be taken in using the hydraulic jack? *A.* The ram should be kept down when not in actual use. In raising a weight the lever should be inserted in the socket with

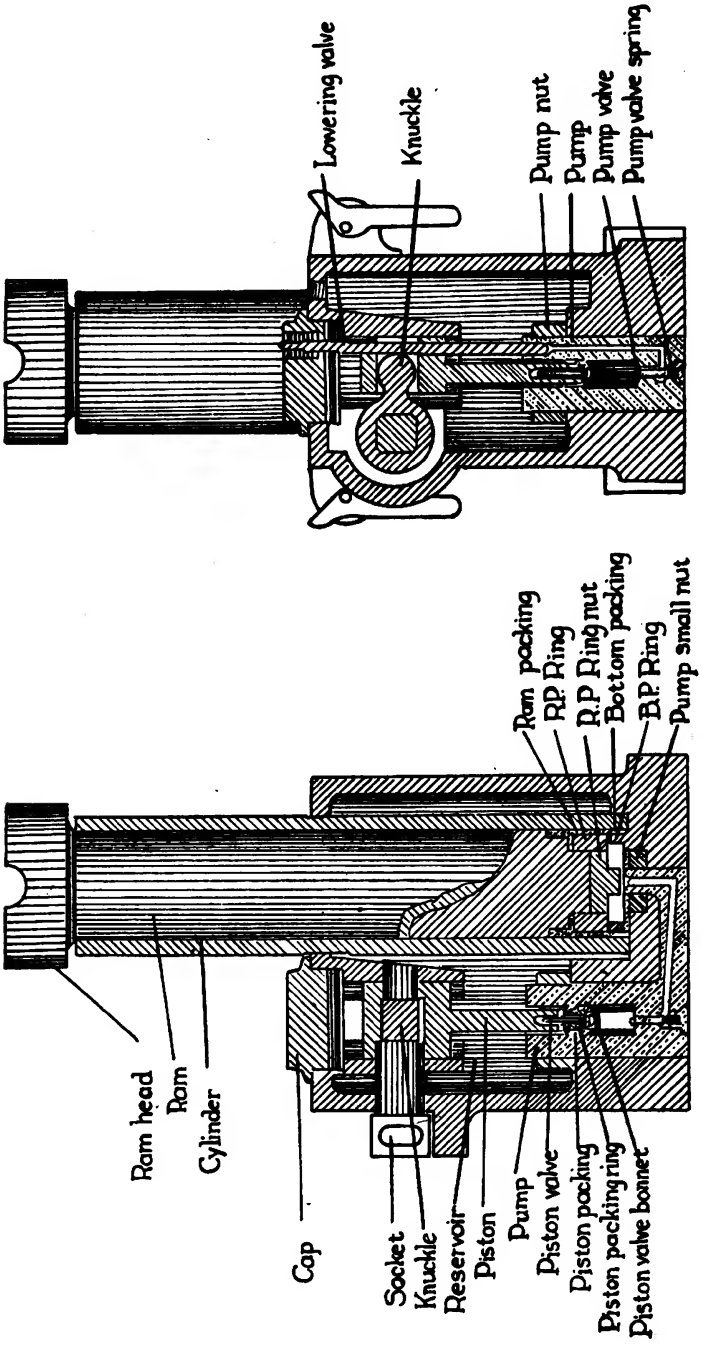


FIGURE 86.—Horizontal hydraulic jack.

the projection down. The lowering valve should be closed. The lever should be worked up and down with a slow steady stroke. A weight is lowered by opening the lowering valve. The speed of low-

ering is controlled by the valve. It should be lowered slowly and never checked suddenly. The jack is designed to lift its rated load with one man operating the lever.

Q. What general precautions should be taken in using the screw jack? *A.* It must never be screwed out to the full extent in raising a weight. The threads must be kept clean, lubricated, and free from burs. The jack should not be used to lift weights greater than its rated capacity.

64. Blocks and wayplanks.—*Q.* What are the requirements of blocks? *A.* Blocks should be sound, free from knots, unpainted, and free from grease. Edges should not be splintered or rounded.

Q. What precautions should be used in erecting a crib? *A.*

(1) The foundation should be level.

(2) Large enough blocks should be selected.

(3) The blocks should then be laid crossing each other in alternate tiers, and the weights supported should be made to bear equally upon all sides of the base.

Q. What is a wayplank and how is it used? *A.* A wayplank is a hard plank, preferably of oak, usually about 15 feet long, 12 inches wide, and 3 inches thick. Each end is beveled for a distance of 6 inches, the bevel on one end being on the side opposite the bevel on the other end. These planks are used chiefly for forming temporary tramways for rollers, or for the wheels of carriages bearing heavy weights, especially in crossing weak bridges.

CHAPTER 10

INDICATION, IDENTIFICATION, AND CHARACTERISTIC FEATURES OF CLASSES OF AIRCRAFT

65. Classes and types of aircraft.—*Q.* What are the two general classes of aircraft? *A.* Heavier-than-air and lighter-than-air.

Q. Name the general types of lighter-than-air aircraft. *A.* Observation balloons and dirigible airships.

Q. What are the general types of airships? *A.* Nonrigid, semirigid, and rigid.

Q. What are the heavier-than-air aircraft generally called? *A.* Airplanes (aeroplanes), seaplanes, flying boats, or amphibians.

Q. What are the general types of combat airplanes used by the United States Army? *A.* Pursuit; bombardment; reconnaissance, observation, and liaison; and transport.

Q. How are pursuit airplanes classified? *A.* Interceptor, single-place fighter, and multiplace fighter.

Q. How are bombardment airplanes classified? *A.* Heavy, medium, and light.

66. Missions of aircraft.—*Q.* What is the normal mission of pursuit airplanes? *A.* The interception, attack, and destruction of enemy aircraft in the air. The *interceptor* is usually a single seater with one or two powerful engines. The *single-place fighter* is used for escort and patrol in addition to normal pursuit missions. The *multiplace fighter* is used for escort and patrol duty near important objectives and against ground-troop formations.

Q. What are the normal missions of *heavy* and *medium* bombardment airplanes? *A.* To carry heavy bomb loads to great distances for attack of material objectives, and also to conduct long range strategic reconnaissance over land and sea.

Q. What are the normal missions of light bombardment airplanes? *A.* Light bombardment airplanes (formerly designated as attack) are designed to attack objectives of light construction, routes of communication, airdromes, troop movements, and concentrations of troops in the open or under light shelter. The light bombardment airplane

is the striking element of combat aviation which operates in direct support of ground forces. Identification of this type of airplane is especially important to ground troops.

Q. What are the normal missions of reconnaissance, observation, and liaison airplanes? *A.* They gather information of the enemy. The two later types operate in conjunction with our own forces performing fire-adjustment missions for artillery; maintaining contact with our front lines and marching columns; and carrying on other command, liaison, and courier missions.

Q. What are the missions of transport airplanes? *A.* Transport airplanes are not strictly a combat type of airplane. They are used for the transportation of personnel and supplies. Their importance is rapidly increasing when we consider the transportation of air-landing troops, parachute troops, and important supplies.

67. Naval aircraft.—*Q.* What types of airplanes are employed by our Navy, and to what types of Army airplanes do they correspond? *A.*

(1) Scouting-observation airplanes corresponding to observation airplanes.

(2) Fighter airplanes corresponding to pursuit airplanes.

(3) Torpedo-bombardment airplanes corresponding to bombardment airplanes.

(4) Patrol airplanes which do not correspond to any special type of Army airplane. The Navy has no type of airplane corresponding to the Army light bombardment airplane.

Q. Does the Navy make more extensive use of the biplane type of airplanes than the Army? *A.* Yes. They are used on carriers and on board other types of warships being launched from catapults. They are used for this purpose because they are more stable in flight at low air speeds than monoplanes.

Q. What are seaplanes and flying boats? *A.* They are airplanes equipped with floats (pontoons) or boat-shaped hulls instead of wheels, so that they may alight on water. Seaplanes have floats while flying boats have hulls.

Q. What is an amphibian airplane? *A.* It is an airplane having a boat-shaped hull, and also equipped with wheels (that can be retracted when operating on water) so that it can alight or take off from either a land or water surface.

68. Identification and indication of aircraft.—*Q.* Why is it important that ground personnel be familiar with the appearance in flight, method of operation, and characteristic sounds of airplanes? *A.* These factors are the means by which airplanes are identified and indicated.

Q. What are the basic flight positions used for ready recognition of airplane types? *A.*

(1) Coming flight or front view.
(2) Passing flight or side view.
(3) Flight at lower altitude or top view.
(4) Overhead flight or bottom view.
(5) Maneuvering flight or perspective view.

Q. What is meant by coming flight or front view? *A.* All positions of flight in which only a general head-on view of the airplane may be had.

Q. What is meant by passing flight or side view? *A.* All positions of flight in which the side of the fuselage, vertical fin, and rudder are the major surfaces presented to view.

Q. What is meant by flight at lower altitude or top view? *A.* All positions of flight in which the upper sides of wings, fuselage, and horizontal tail surfaces are the major surfaces presented to view.

Q. What is meant by overhead flight or bottom view? *A.* All flight positions in which the under sides of wings, fuselage, and horizontal tail surfaces are presented to view.

Q. What is meant by maneuvering flight or perspective view? *A.* All flight positions which are different from straight and level flight. It includes banking, turning, climbing, diving, and combinations of such maneuvers. The airplane may present, momentarily at least, nearly all of the views presented under other conditions of flight.

Q. What characteristics of outline of the airplane are most readily seen in overhead flight? *A.*

(1) *Shape of wing.*—The general shape and proportion of wings, as long and narrow, short and stubby.

(2) *Type and shape of nose.*—Nose extends much or little in advance of leading edge of wings; that is, plane is long-nosed or short-nosed.

(3) *Length and shape of fuselage.*—Compare the relatively short fuselage of the small and medium sized airplanes with the long, slender, streamlined appearance of the larger types.

(4) *Location and number of engines.*—In single engined airplanes the engine is located in the nose and by its type determines the shape of the nose; that is, with radial engines the nose is blunt and stubby, while with in-line and V-type engines the nose is more slender and pointed. In multi-engined airplanes the engines are usually housed in nacelles extending from the leading edge of the wings. In the unusual pusher types, the engines extend from the trailing edge of

the wings. Even at great altitudes when the number of engine nacelles cannot be exactly determined, their presence will give an unmistakable irregular outline to the wings warranting identification as multi-engined.

Q. What characteristics of outline are most readily seen in passing flight? *A.*

(1) *Shape and outline of the fuselage.*—It is short and chunky in smaller pursuit types; elongated and streamlined in larger types; long and thick bodied in larger bombardment types. Note outline being broken by such parts as cockpits, canopies over cockpits, and gun turrets.

(2) *Shape of nose.*—It may be slender and pointed, blunt and stubby, smoothly rounded, or shark-nosed.

(3) Note the *relative size of the vertical fin and rudder* compared to the fuselage.

Q. What characteristics of outline are most readily seen in coming or going flight? *A.*

(1) *Relationship of wings to fuselage.*—Has high-wing, midwing, low-wing, or parasol-wing types; dihedral angle, pronounced, moderate, or practically zero.

(2) *Number of engines.*—The irregularity of outline of wings will indicate a multi-engined type.

(3) *Features of the vertical tail members.*—It is usually possible to identify single- and double-rudder types.

(4) *Undercarriages.*—Nonretractable landing gear is usually plainly visible.

Q. What characteristics of outline are most readily seen in maneuvering flight? *A.* All the features previously pointed out may be momentarily visible.

Q. What characteristic methods of operation of pursuit assist in its identification? *A.* Pursuit normally operates in formation with the squadron of eighteen airplanes as the largest group operating as a unit. An observer noting one such formation should look below and to the front of it and above and to the rear of it for other units.

Q. What characteristic methods of operation of heavy and medium bombardment assist in its identification? *A.* They operate in column of three plane elements (route column) with successive elements stepped up or down from front to rear. They usually fly straight courses at medium or high altitude unless attacked from the air or by antiaircraft fire.

Q. What characteristic methods of operation assist in the identification of light bombardment? *A.* They operate in formation at mini-

mum or medium altitudes. They use the three plane element echeloned to the rear at approximately the same altitude. The normal operating unit is the squadron of nine airplanes with the largest formation the group of three squadrons. This type of aviation supports the operations of ground troops.

Q. What characteristics of operation of reconnaissance airplanes assist in their identification? *A.* They operate at any altitude from low to high; usually operate singly; fly straight courses unless attacked. Bombardment airplanes may perform long range reconnaissance.

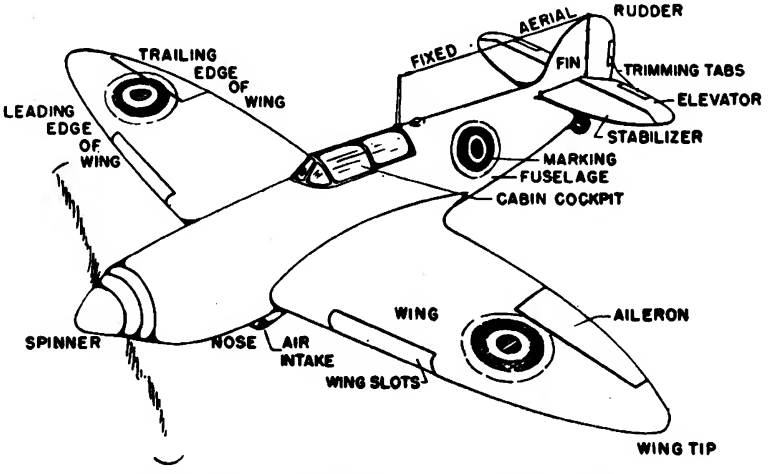


FIGURE 87.—Nomenclature of airplane parts.

Q. What characteristic methods of operation assist in identification of observation and liaison airplanes? *A.* They operate almost entirely within own lines; fly singly on various courses at low and medium altitudes; will be seen circling over own troops and troop columns to drop messages and observe panels.

Q. What are some of the characteristic sounds of pursuit airplanes in flight? *A.* Pursuit airplanes in flight are characterized by sounds of fast rhythm, high pitch, moderate volume, and by extreme variations in pitch and tone while maneuvering.

Q. What are some of the characteristic sounds of heavy and medium bombardment airplanes while in flight? *A.* They have a fairly deep pitch, a moderately heavy volume, and a steady tone and rhythm.

Q. What are some of the characteristic sounds of light bombardment airplanes while in flight? *A.* They have a heavy volume of sound due to low altitude; a fairly deep pitch, with tone and rhythm steady but varying considerably when maneuvering.

Q. State, in the order in which given, what information is given and the terms used in indicating aircraft during daylight. *A.*

(1) *Designation of the reporting station* by name or number.

(2) *Number of airplanes*, when they can be counted. If they cannot be counted the word "several" or the word "many" may be used.

(3) *Type of airplane*, such as "observation," "pursuit," etc., when they can be identified. In other cases the word "airplane" is used.

(4) *Altitude*, in general terms as follows: "very low" (below 500 yards); "low" (500 to 2,000 yards); "medium" (2,000 to 5,000 yards); or "high" (over 5,000 yards).

(5) *Location*, by the sector in which or toward which the aircraft are flying.

(6) *Direction of flight*, by one of the eight points of the compass: north, NE, east, SE, south, SW, west, NW.

Q. State which of these elements of information are given in indicating aircraft at night. *A*. Designation of reporting station, number of airplanes ("one," "several," or "many"), altitude, and location.

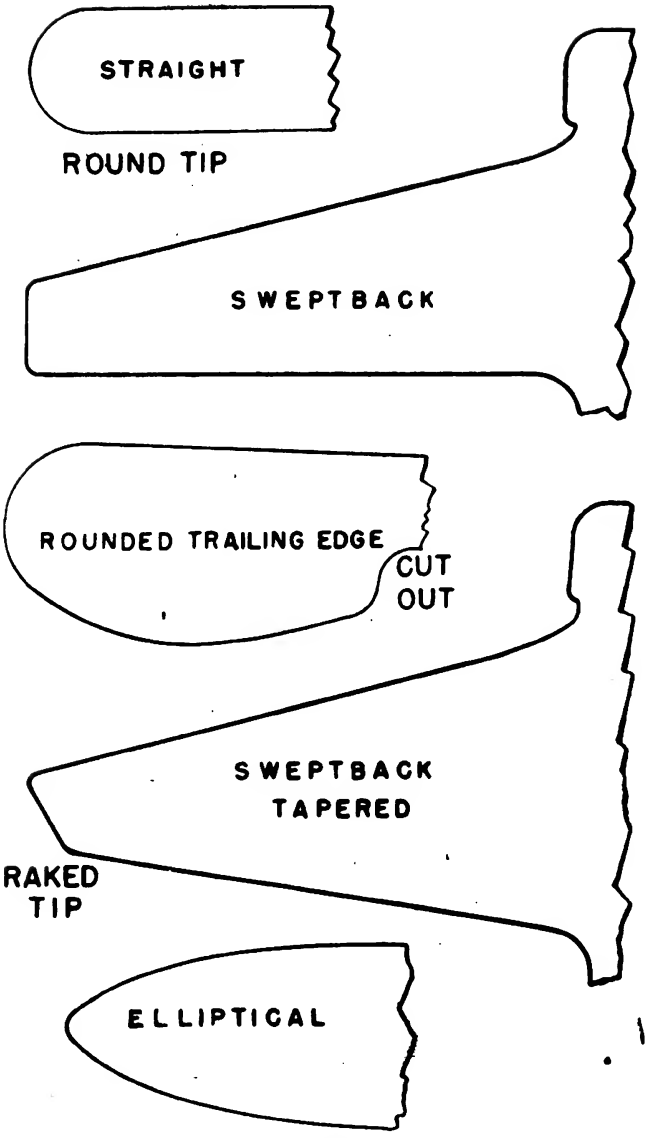


FIGURE 88.—Wing shapes.

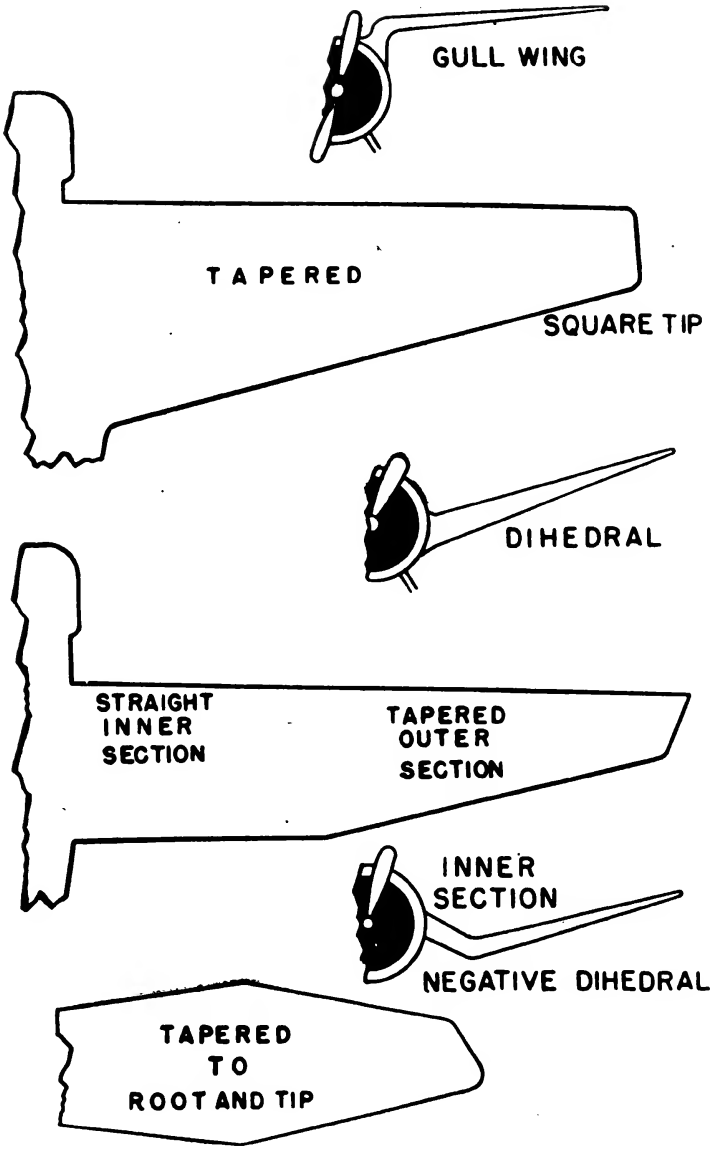
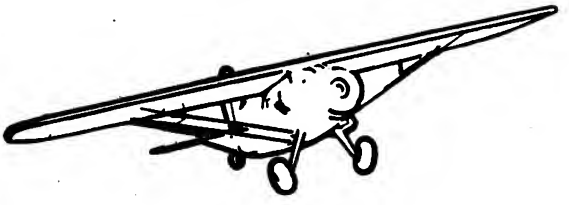
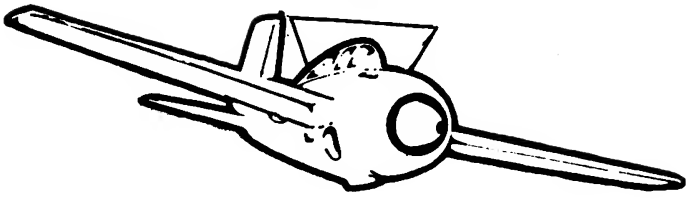


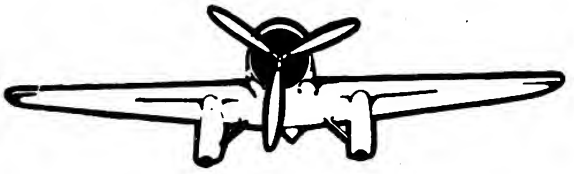
FIGURE 88.—Wing shapes—Continued.



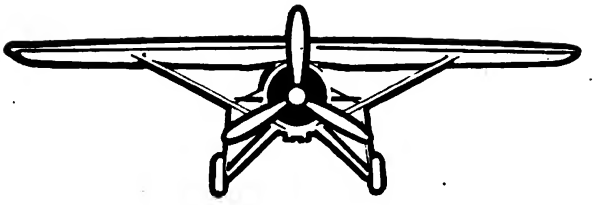
HIGH-WING



MIDWING



LOW-WING



(PARASOL MONOPLANE)

FIGURE 89.—Monoplanes.

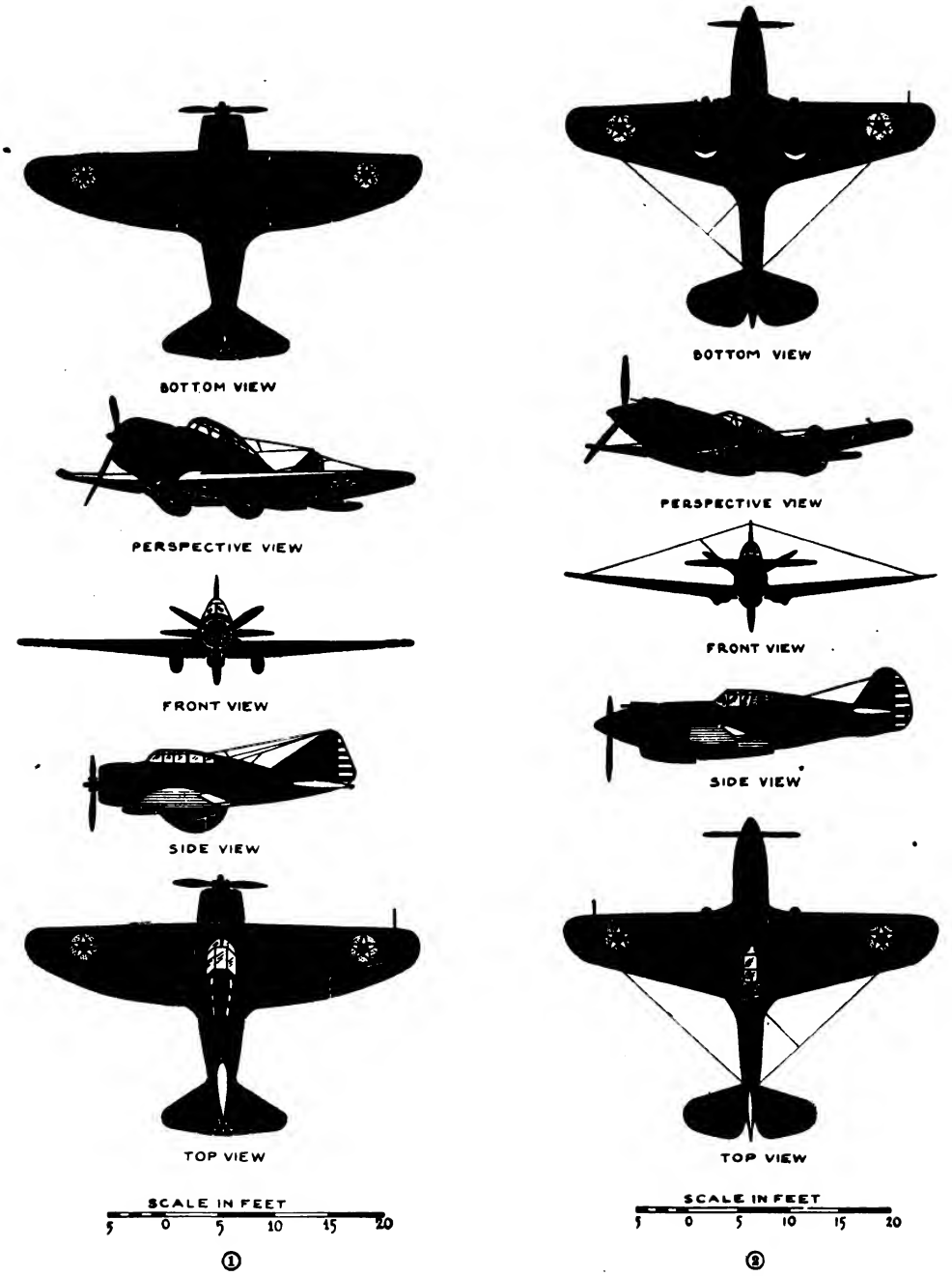


FIGURE 90.—Pursuit airplane.

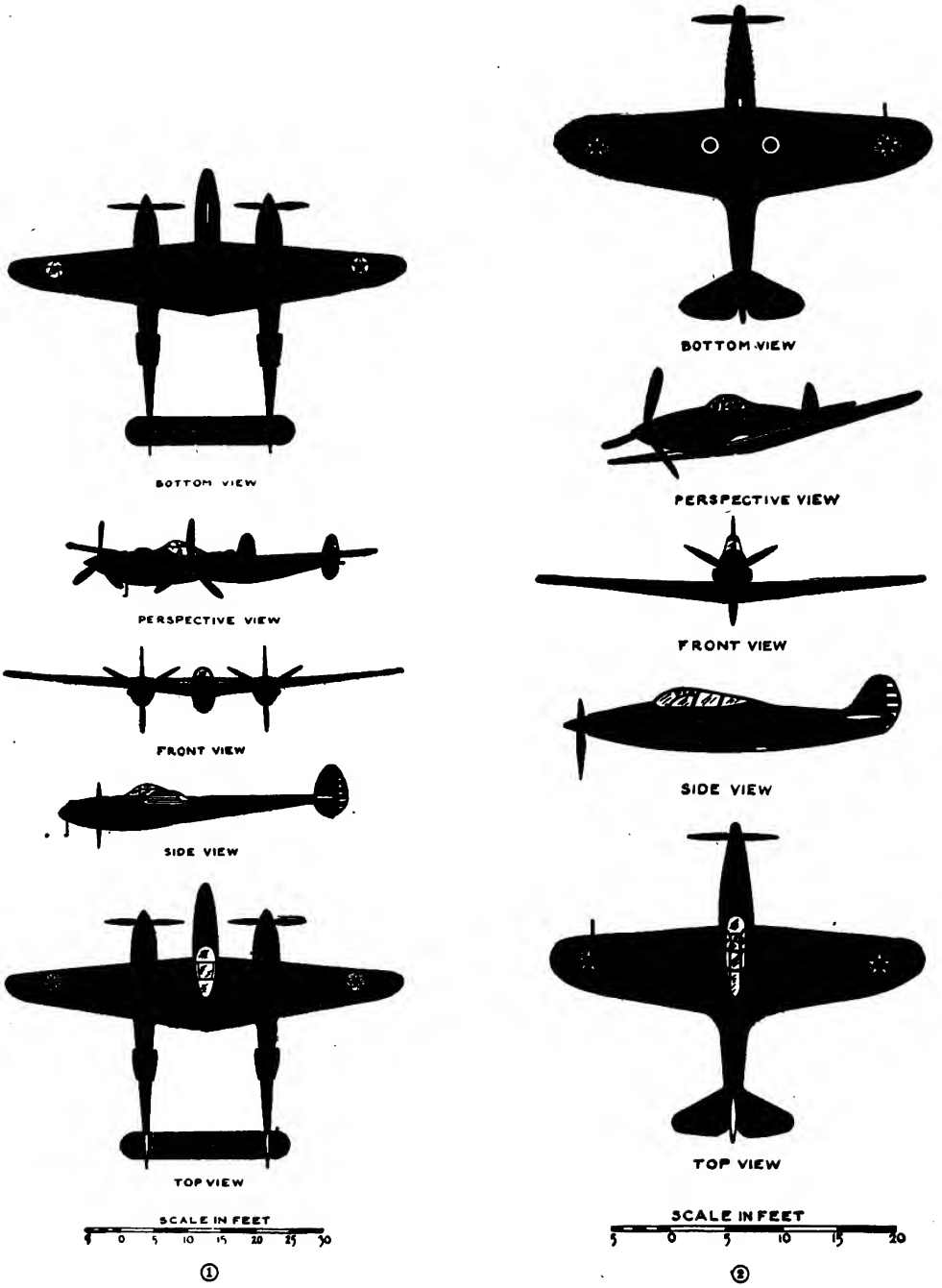


FIGURE 91.—Pursuit airplane (interceptor).

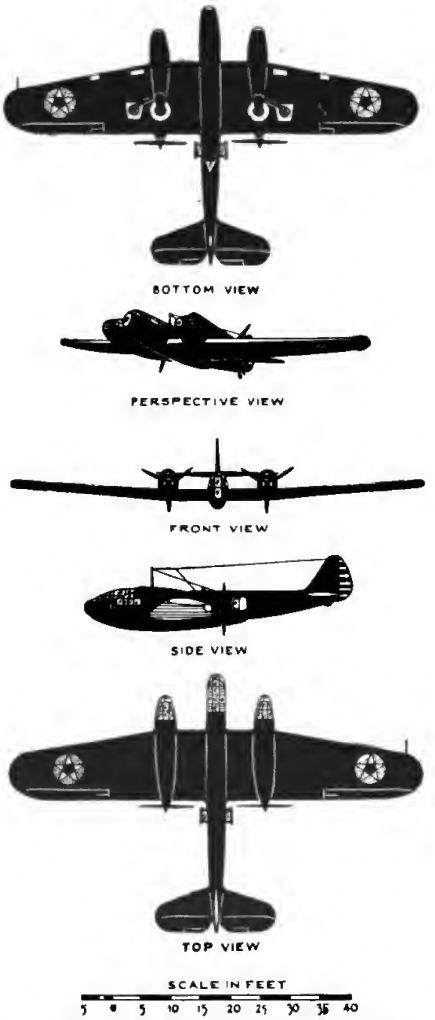


FIGURE 92.—Multiplace fighter airplane.

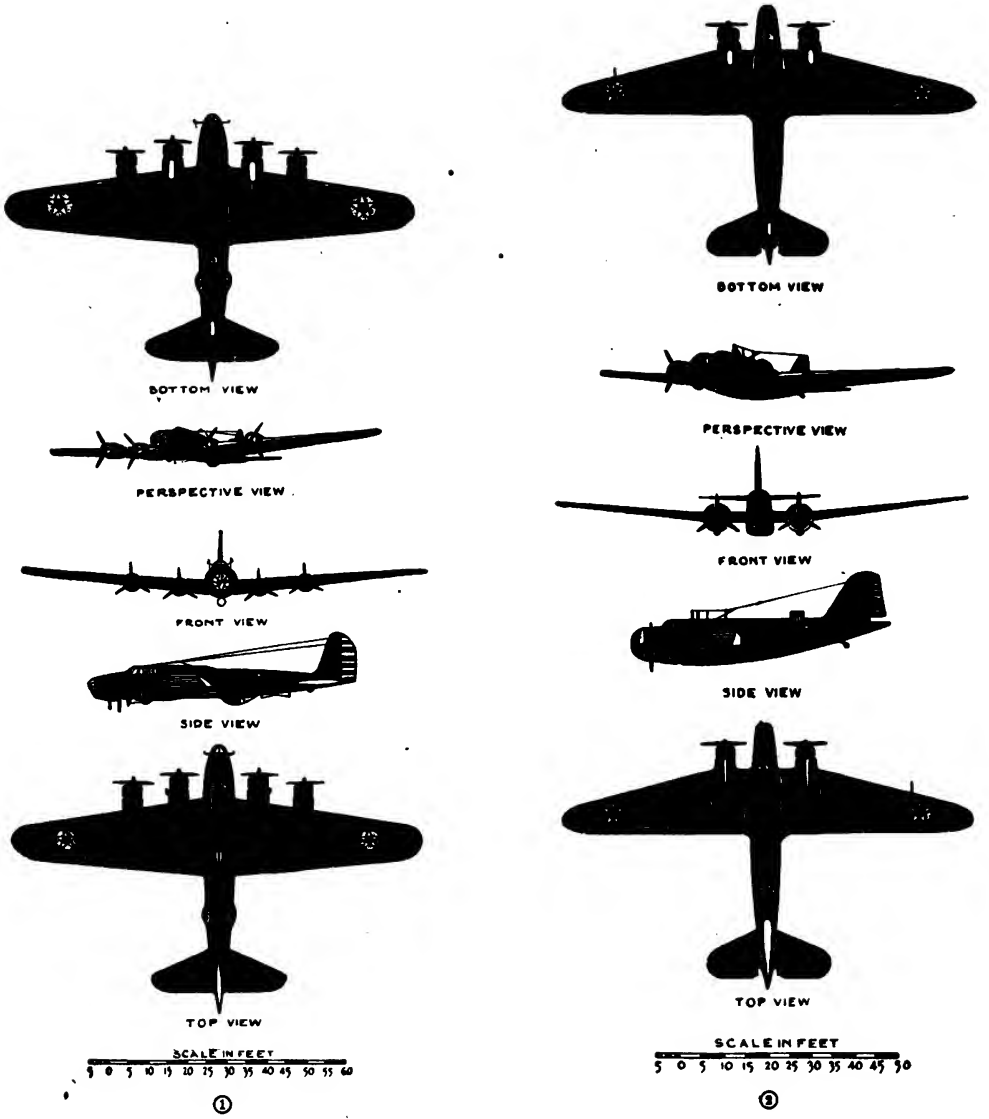
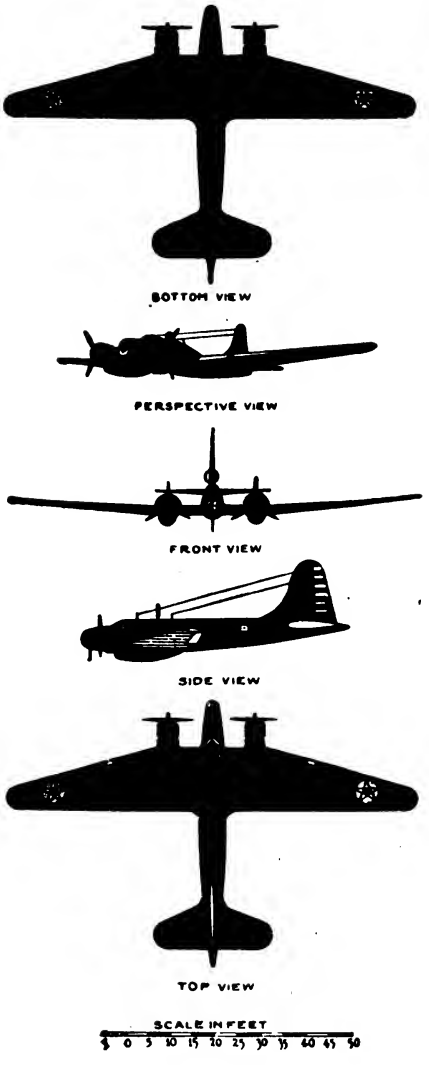


FIGURE 93.—Bombardment airplane.



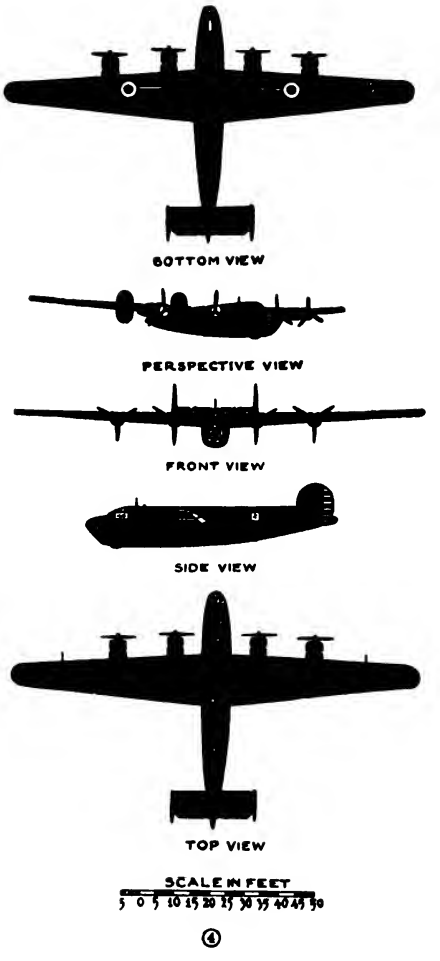


FIGURE 93.—Bombardment airplane—Continued.

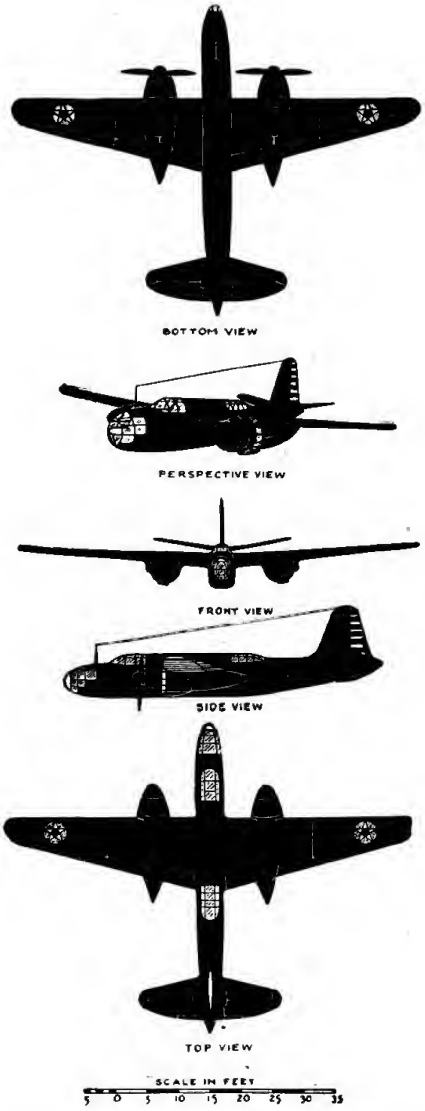


FIGURE 94.—Light bombardment (attack) airplane.

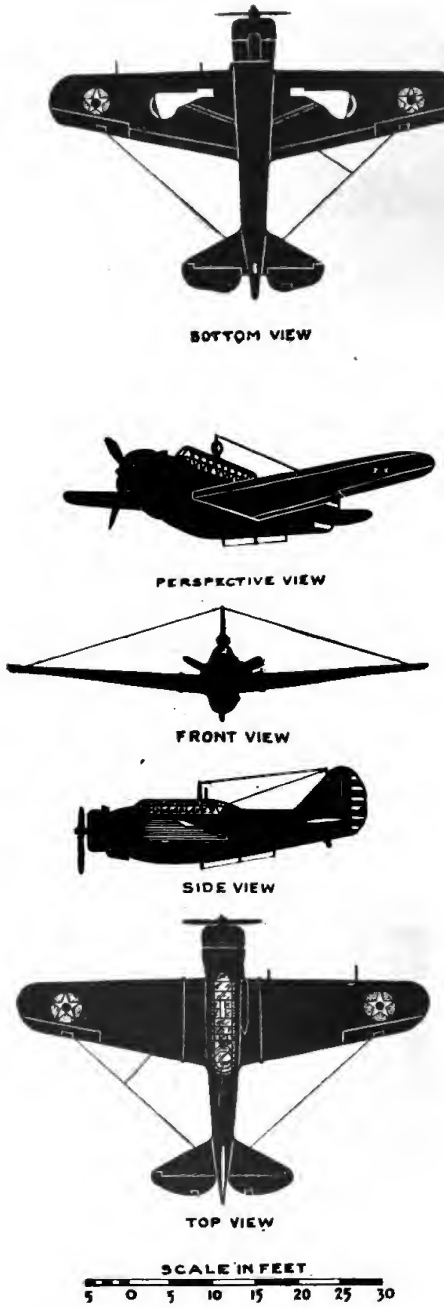


FIGURE 95.—Observation airplane.

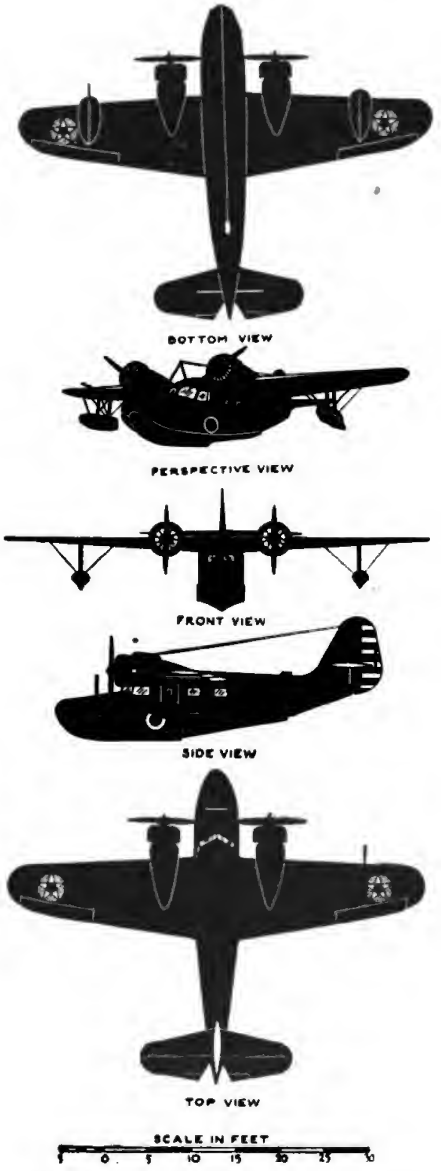


FIGURE 96.—Observation amphibian airplane.

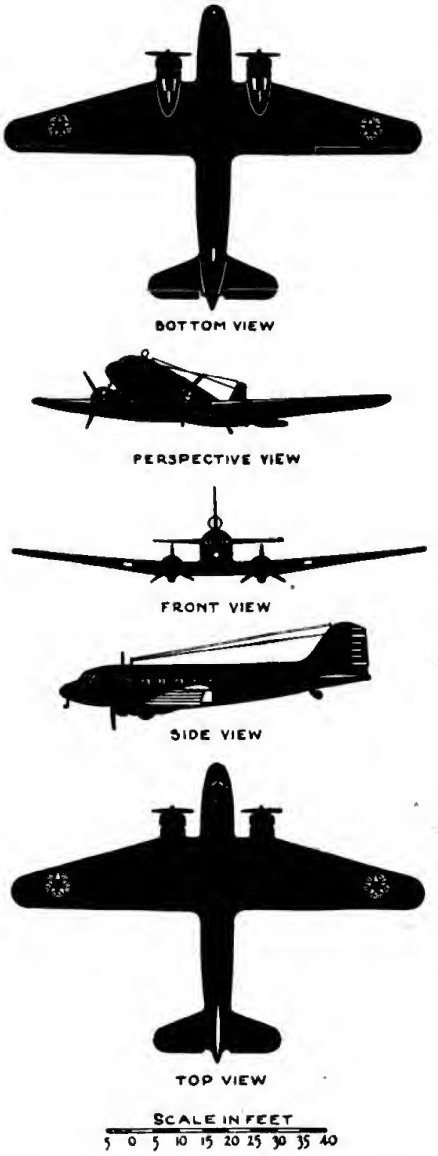


FIGURE 97.—Transport airplane.

INDEX

INDEX

INDEX

[A. G. 062.11 (6–13–41).]

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IBn and H4 (3); IC4.

(For explanation of symbols see FM 21 6.)

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